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POWER PLANT IN THE W. C. SEIPP BUILDING

4-VALVE ENGINE AND TOP FEED FURNACES

MODERN small power plants for generation of electricity differ widely in design and operation from those of like capacity equipped with machinery that was new even 10 yr. ago, a good example of the old and new systems being the plant in the basement of the W. C. Seipp building in Chicago.

The increased electric power and light required by the clothing manufacturers who occupy this building

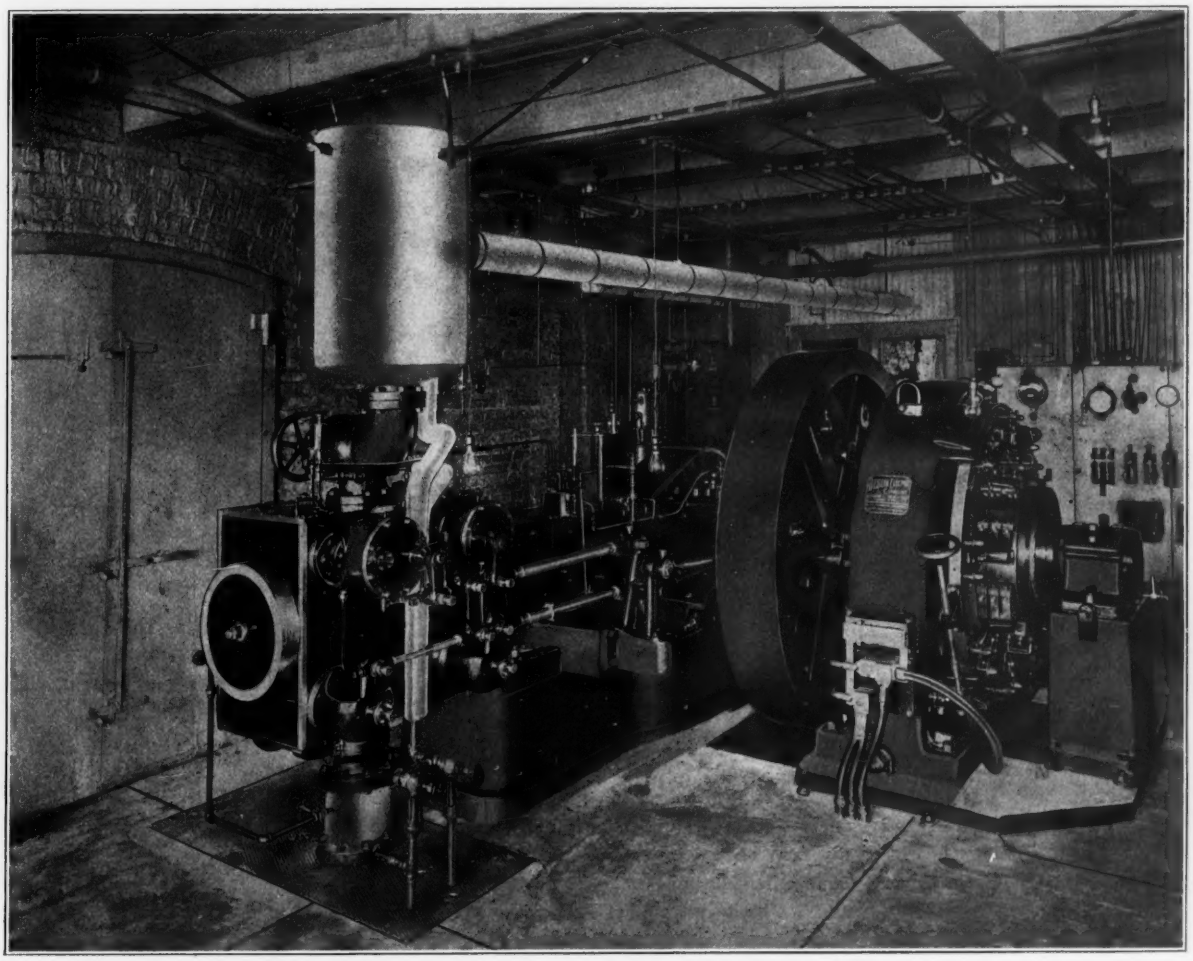


FIG. 1. NEW GENERATING UNIT IN THE SEIPP BUILDING

made it necessary that the plant be enlarged, and it was found that by changing somewhat the arrangement of the old machinery sufficient space still remained in the engine room to install a modern unit with a capacity equal to nearly twice that of the former equipment.

Engine Room

Figure 1 shows the engine and generator recently installed. This engine was made by the Ball Engine Co. of Erie, Pa., and is a model of perfection in operation; it has a cylinder 14 by 20 in. and runs at a speed of 200 r. p. m., being rated for a capacity of 160 hp.

The distinctive feature of this engine is the non-releasing Corliss valve gear, which equipment makes it possible to secure the same effects in steam expansion that are obtained by the standard releasing Corliss valve. In addition, however, the gear mechanism used on the Ball engine permits a speed much higher than is possible to employ with the releasing Corliss valve.

The working parts of this gear are shown in Fig. 4, and their operation may be explained briefly as follows: The rocker arm E is driven from the eccentric, the position of which is controlled by a flywheel governor; this oscillates the shaft F, to which the arm X is solidly keyed. Y is the valve stem to which the arm YD is keyed. The link CD is connected to the arm YD at D, and at C is connected to the center of the link BA; this link is coupled at A to the driving arm X, and at B to an arm which pivots loosely on the valve stem Y.

If the gear, as shown in the cut, be operated by moving E to the left, a short movement will bring it to the point where it will begin to move D around Y and to open the valve. If, on the other hand, E be moved to the right, no movement of D will result; C will simply swing around D as a center and D will remain motionless for fully half the total oscillation of E. If the link CD be removed entirely, the center of the link BA which carries the pin C would still move in the arc of the circle around D, upon moving E to the right. This mechanism operates in a bath of oil and is perfectly noiseless.

The oiling system of this engine consists of a tank from which the oil flows to all parts of the engine by force of gravity and after passing through the bearings is delivered to a well from which it is pumped back to the tank. Before entering the engine, the steam passes through a Baragwanath steam separator, 20 by 36 in., which was specially designed to meet local conditions of low ceiling and overhead piping. The method of firmly bracing this combined vertical and horizontal separator is shown clearly in Fig. 1.

Directly connected to this engine is a direct-current generator made by the Western Electric Co. of Chicago, with a capacity of 100 kw., generating current at 125 volts and running at a speed of 200 r. p. m.

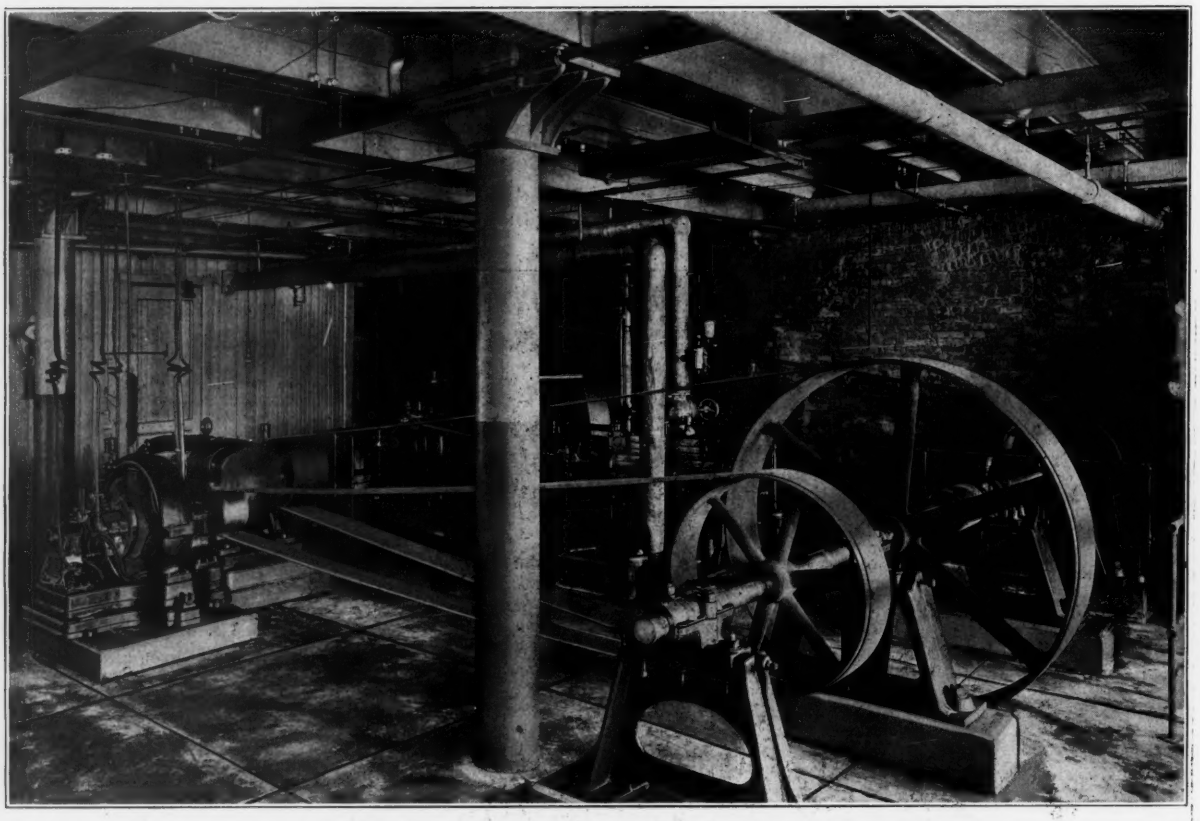


FIG. 2. FORMER EQUIPMENT NOW USED AS AUXILIARY

The former equipment of the plant, which is shown in Fig. 2, is now used as an auxiliary and consists of a shown in Figs. 1 and 2. The leads from the new generator, however, are run through iron conduits to the

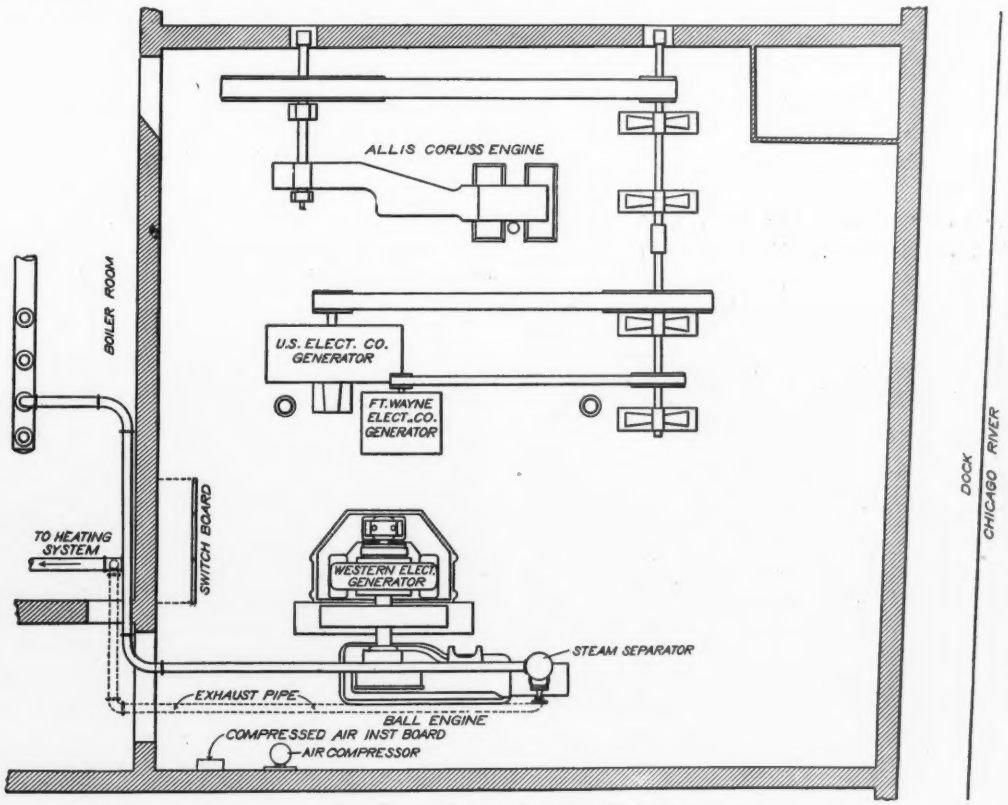


FIG. 3. LAYOUT OF ENGINE ROOM

Corliss engine which was made by the E. P. Allis Co., now the Allis-Chalmers Co., and has a cylinder 12 by 30 in. This engine is belted to a line shaft, from which 2 generators are run. The general layout of the engine room is shown in Fig. 3, which gives clearly the position of all apparatus.

One of these generators was made by the U. S. Electric Co. and has a capacity of 30 kw., generating direct current at a voltage of 120 and running at a speed of 850 r. p. m. The other generator is of a later style made by the Ft. Wayne Electric Co. It also has a capacity of 30 kw. and generates direct current at 120 volts, running at a speed of 750 r. p. m.

Switchboard and Circuits

Figure 1. illustrates the advancement in switchboard equipment since the original plant was put into operation. The switchboard now consists of 3 panels. The old panels, which are 2 in number, are equipped each with a Chas. E. Gregory ammeter, a number of knife switches and rheostats of the Wood system, which are fastened to the front of the board. The new panel, however, is equipped with the latest designs of Weston ammeter, carbon tipped circuit breakers and rheostat hand wheels. One Weston swinging voltmeter serves for the 3 generators, which are connected to be operated in parallel.

Another feature of the engine room which attracts attention is the open system of wiring which is clearly switchboard and thus a mass of overhead wiring in that part of the room is done away with.

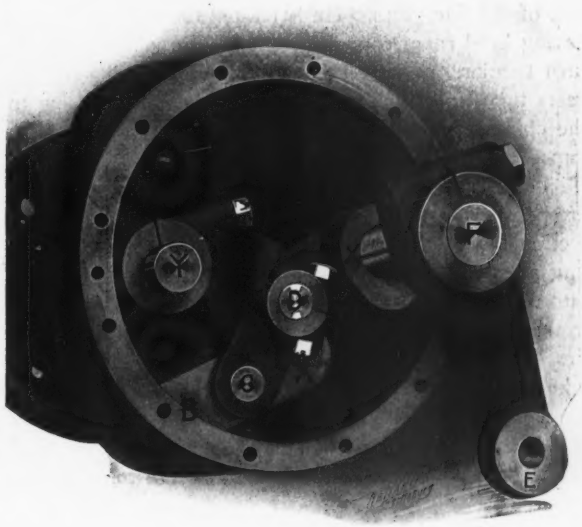


FIG. 4. STEAM VALVE GEAR OF BALL 4-VALVE ENGINE

In the engine room is also located an air compressor of the locomotive type made by the New York Air Brake

Co., which is used to maintain pressure in the dry air pipes in the sprinkling system for fire protection of the building.

The exhaust steam from the engines is used in the heating system of the building with a back pressure on the engines of from 1 to 2 lb.

Boiler Room

The steam used in driving the engines is generated by 2 Kroeschell Bros. tubular boilers, shown in Fig. 5, which have a capacity of 100 hp. each, 18 ft. by 66 in., fitted with Burke furnaces, made by the Burke Furnace Co. of Chicago. The boiler room also contains 1 Baker & Smith boiler, which is to be replaced by a Kroeschell. All boilers are equipped with American steam gages and Huyette weighted trycocks.

FIG. 5. VIEW OF BOILERS AND FURNACES

One of the important problems of the power plant engineer in a city building is to secure complete combustion of the flue gases. He is limited on one side by not having head room enough to employ furnaces under return tubular or water-tube boilers which will give the gases time to become thoroughly burned before going to the chimney, and on the other by city authorities who impose a fine for creating a smoke nuisance.

The Burke furnaces which are installed in this plant are peculiarly well adapted to basement power plants. A sectional view of this furnace is shown in Fig. 6, which illustrates the mode of combustion. The coal is shoveled into the hoppers at the sides and feeds by its own weight to the shaking grate in the center. As the coal enters the fire box it becomes thoroughly coked and combustion takes place rapidly when this coke is pushed to the center of the grate. The gases are not chilled by striking a cold boiler when only partly consumed, but are allowed to undergo almost complete combustion before touching the boiler.

The furnace is securely braced to insure against cracking due to the expanding effect of heat, and air vents in the front suffice to keep the side walls cool.

Three Worthington simple duplex steam pumps are employed, 1 for house service, and 2 for feeding the boilers, 1 of which is a standby. A Marsh vacuum pump made by the American Steam Pump Co., Battle Creek, Mich., is used to draw water from the returns of the heating system.

Steam pressure carried on the boilers is from 100 to 125 lb. and the water pressure for house service 55 lb. Two tanks are located in the boiler room, 1 to receive condensation from the heating system with a spray inside to condense the vapor and a skimming device to remove the oil. This tank acts also as a hot well from which the boiler feed pumps take their supply; the other tank acts as a supply, taking water from the city mains.

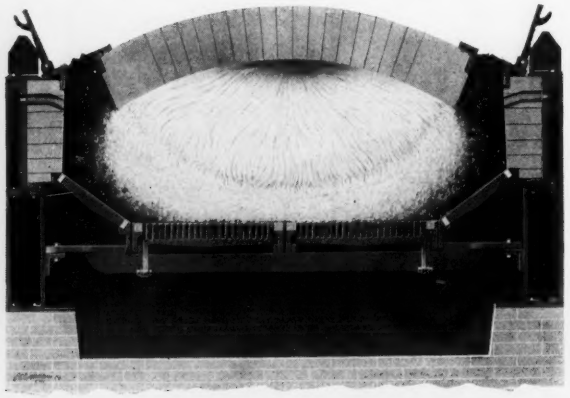


FIG. 6. SECTIONAL VIEW OF BURKE FURNACE

Exhaust steam from the engines goes to a Kroeschell closed heater; then through an oil separator to the heating system. The boilers supply steam for 2 steam operated freight elevators and 1 passenger elevator, the engines used on these elevators being made by the Crane Elevator Co. of Chicago.

The chief engineer of this plant is Gust. E. Lundquist, who, by his knowledge of power plant operation, has made possible large profits to the owner of the plant, and who has co-operated with C. R. Kreider of the Ball Engine Co. in carrying out the rearrangement and improvements.

A CORRESPONDENT OF THE Gas Review states in regard to packing the heads of gas engines that ordinary asbestos packing without wire, cut to shape, and moistened before screwed down will give excellent results. The wetting of the asbestos softens it so that it forms a firm joint the first time the bolt heads are screwed down and gives just enough rust to keep the joint tight.

TO FIND THE AREA required for the valve opening in a gas engine, multiply the diameter of the cylinder in inches by the length of the piston stroke in inches and by the greatest number of revolutions a minute and divide the product by 13,500. Care should be taken that all passages into the cylinder have as great an area as the valve opening.

NOTES ON HYDRAULIC TURBINE PRACTICE

By Frank Koester

Types

As regards the behavior of the water, turbines may be classified in 2 general types, the reaction and impulse. In the former, the flow of water must be continuous in all parts of the turbine, that is, the entire runner is under water; in the impulse type, the water impinges on parts of the wheel, and in nearly all cases the atmospheric air has free access to the remainder of the runner.

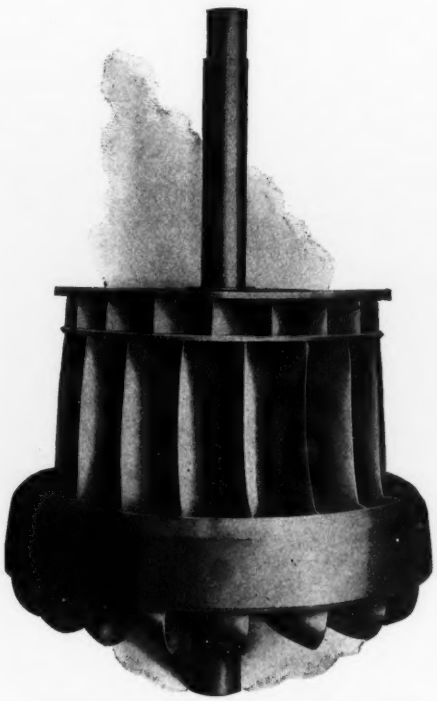


FIG. 1. COMBINED FLOW TYPE TURBINE RUNNER, MADE BY JAMES LEFFEL & CO. OF SPRINGFIELD, O.

Turbines may be further divided, as regards their construction, into radial, axial or parallel flow, and combined or mixed flow. In the radial type the water passes through the wheel either inward or outward to the axis of rotation. In the axial turbine the general direction is parallel to the axis of rotation. In the mixed flow turbine the water enters radially and discharges axially, or vice versa. The different types of reaction turbines are commonly known by the names of their inventors, as the Fourneyron, which is a radial outward flow; the Francis, a radial inward flow, and the Jonval, a parallel flow.

A combination of the Jonval and Francis is known as the American type, and is today the most common one used in America, where it had its origin. Of the impulse type, the Girad and Zuppinger in Europe, and the Pelton in America, are the most familiar.

In regard to the origin of the impulse wheel, it might be of interest to state that, according to Professor Escher in the Zeitschrift des Vereines Deutscher Ingenieure, Feb. 18, 1905, Zuppinger in 1864 installed the first tangential wheel at Weiler's Mills, near Friedrichshaffen on Lake Constance. The same engineer, who was at that time connected with the Escher, Wyss Co., built, in 1868-9, for the Haemmerle Cotton Mill in Dornbirn, Voral Mountains, Germany, a tangential turbine of 220 hp. capacity, making 300 r. p. m. under a head of 550 ft. According to L. Zodel in the Schweitzerische Bauzeitung, June 13, 1908, this tangential impulse wheel was 5 ft. in

FIG. 2. VICTOR FRANCIS RUNNER, MADE BY PLATT IRON WORKS CO.

diameter, 30 in. wide, and mounted upon a vertical shaft and provided with 2 diametrically opposite jets or nozzles. It was designed for a water supply varying from 1 to 6 cu. ft. a second, and as the designer up to that time had not constructed wheels to operate over 380 ft. head, he thought it advisable not to give a guarantee over 65 per cent. However, during actual operation, and with a water consumption of 1.5 to 2 cu. ft. a second, the efficiency was 70 to 75 per cent, and with a water consumption of about 5 cu. ft. a second, was 65 to 70 per cent.

Another classification of turbines is made according to the head under which they operate, and may be as follows:

(1) Low head, up to 30 ft.
(2) Medium head, from 30 to 200 ft.
(3) High head, above 200 ft.

This classification is not strictly adhered to, as is evidenced by the fact that many low and medium head wheels have been installed under high heads, and vice versa, but not to such a great extent. In connection

with this it must be borne in mind that low head turbines are less efficient when installed under high heads, and vice versa. It is also true that the efficiency of water wheels frequently can be increased by cutting down the water supply, contrary to the opinion of many engineers who would turn on more water in attempting to attain the same effect; an interesting example is cited in the above Zuppinger test.

A classification for European turbines is given in Hütte, and is strictly adhered to, unless other conditions warrant a change.

Low head turbine, up to about 10 ft. With open flumes, vertical shafts with bevel gearing. When above ground water, horizontal shaft with belt or rope drive.

First intermediate head turbine, from 10 ft. to about 35 ft. Open penstock, which is possible up to 35 ft., vertical shaft or when advisable, horizontal.

Second intermediate head turbine, from 35 to about 165 ft. Closed penstock, spiral casing, horizontal shaft. Of course for special conditions vertical shafts may be used.

High head turbines, above 165 ft. Closed penstock, spiral casing, horizontal shaft as long as reaction wheels are considered; otherwise, impulse wheels with horizontal or vertical shafts.

In American practice the low head turbine, a combination of Francis and Jonval types, is manufactured in horizontal and vertical, and frequently a number of runners are mounted upon a single shaft. They are located in open flumes, and very frequently in closed flumes or casings, thus approximating a low head turbine under a high head, contrary to European practice.

Most of the above turbines are tested at the flume of the Holyoke Water Power Co., Holyoke, Mass. As the head of this plant is but 18 ft., and is seldom constant, due to great fluctuations, therefore all the readings have to be reduced to a uniform head.

Further, as the conditions of the flume and setting of the wheel are entirely different from those at the plant where the wheel is to be installed, the value of the Holyoke tests may be judged from the following comparison:

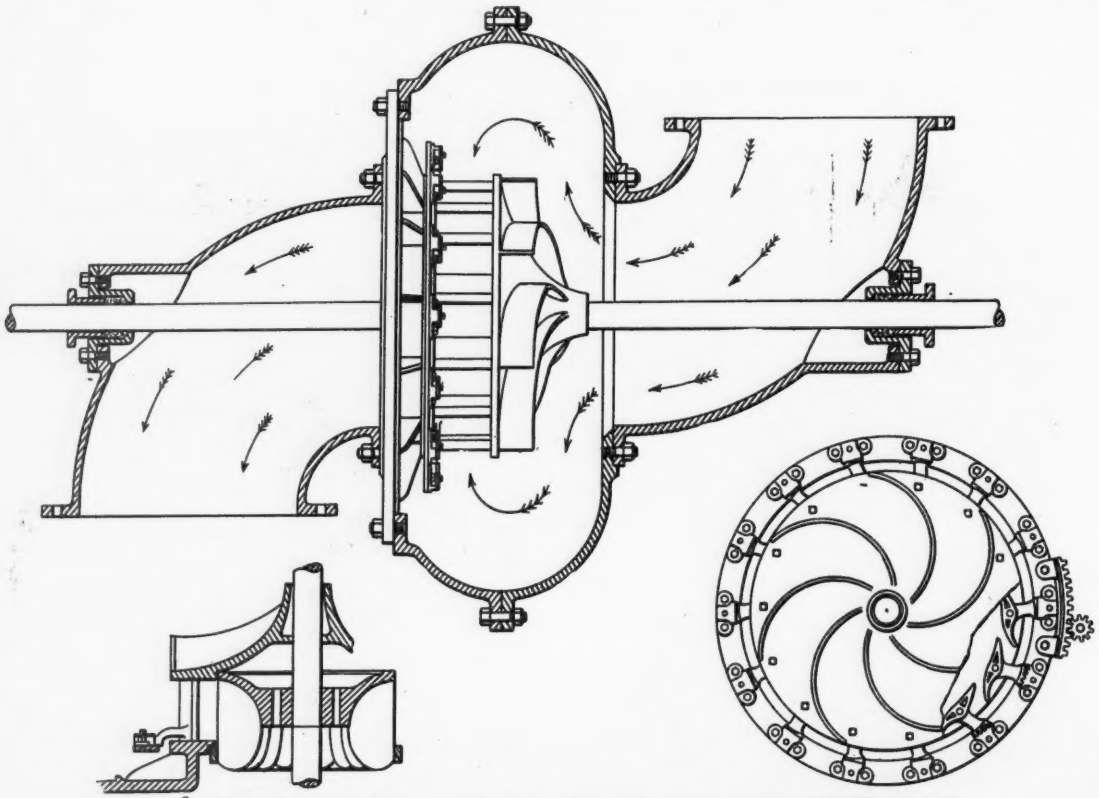


FIG. 3. SECTIONAL VIEWS OF HIGH HEAD TURBINES MADE BY THE TRUMP MFG. CO.

TABLE 1. COMPARISON OF HOLYOKE AND GERMAN TESTS

DISCHARGE	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3
HOLYOKE TEST	0.81	0.795	0.765	0.725	0.67	—	—	—
GERMAN "	0.718	0.703	0.693	0.658	0.591	0.491	0.358	0.121

Due to the high efficiency claim of some American manufacturer, a German concern intended to build turbines after the American type, for which purpose it bought a 16-in. turbine, duly tested at Holyoke, then tested in Germany by Professor Pfarr, one of the highest German authorities on turbines. The results of these tests are published in the Zeitschrift des Vereines Deutscher Ingenieure, June 7, 1902; the comparison of efficiencies is shown in the table.

The discharge is the actual discharge and is not figured on the proportional gate-opening. During the Hol-

yoke tests the total weight on the step bearing was 25 per cent greater than that in the German test.

For the above reasons, guarantees of such tests must not be blindly accepted by the power plant designer; he should accept such guarantees as are made in the power plant itself, which is today common practice in steam engineering.

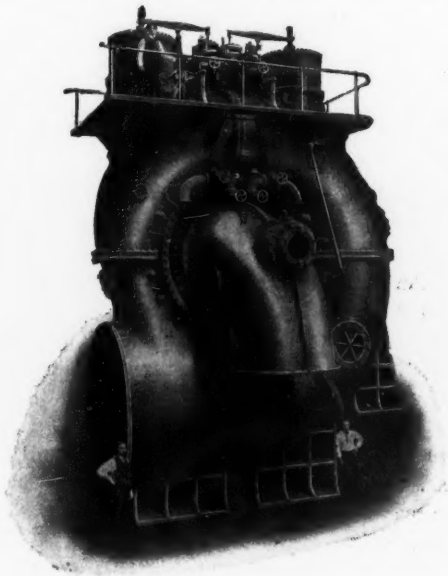


FIG. 4. 10,500 HP. TURBINE AT SHAWINIGAN, MADE BY I. P. MORRIS CO.

As the line of demarcation between low and medium, and medium and high head, is not distinctly drawn, one will find under medium head installations a great variation of turbines, including high and low head types. The majority of turbines used under medium head are of the Francis type. The wheels are mounted on either vertical or horizontal shafts, and singly or in pairs, and are placed either in an open chamber forming part of the power house, or in a closed chamber made of cast iron or structural steel; the latter are either cylindrical or spiral in form.

COLD ROLLED STEEL SHAFTING weighs about as follows: 1-in., 2.68 lb. per lineal foot; 1.25-in., 4.17 lb.; 1.5-in., 6.01 lb.; 1.75-in., 8.18 lb., 2-in., 10.69 lb.; 2.25-in., 13.52 lb.

A DESTRUCTIVE BOILER EXPLOSION

ON February 19, at 7 o'clock in the morning, a number 2 boiler in the Battery of 5, located at the plant of the Liverpool Salt and Coal Co.'s works, Hartford, W. Va., exploded with great force, killing the engineer, and a man who with 4 others was at work nearby refitting a salt well, and injuring 3.

The boiler was 72 in. diameter by 18 ft. long, having 70 tubes, and with tube plates and shell 7/16 in. thick. There were five through stays under the flues, and 18 head braces above the flues, the boiler carrying 80 lb. pressure. In the feed water was a great deal of brine, which attacked the steel of the boiler, pitting the inside of the shell and tubes badly, as the plates of the wrecked boiler plainly showed. On the fire sheet right over the fire was a soft patch and a corroded groove followed the curvilinear seam on the inside of the boiler near the soft patch, which was wasted away almost to a knife edge. This indicates clearly enough that the boiler was not in serviceable condition.

Low water was given out as the cause, but the bad condition of the plates was evidently the trouble. The wrecked boiler certainly shows abnormal pressure, as plates and rivets were sheared at about the proper angle for calking. The sheets were laid out almost flat, as shown in Figs. 1 and 2, of which Fig. 1 shows the battery, the boiler which exploded having stood next to those left standing with another boiler, No. 1, on the right. The end boiler, as shown in Fig. 3, was blown sidewise through the base of the derrick over the well.

Tubes were scattered in a semi-circle with a radius of 1,000 ft., some alighting on their ends and sticking upright in the ground. The dry pipe struck on a hillside, coming straight down and driving 2 ft. into the ground. The safety valve and a 6-in. cast-iron stop valve weighing 125 lb. was carried over the tops of houses, going a distance of nearly 1,200 ft. and landing on the track of the B. & O. R. R.

FIG. 1. BATTERY OF BOILERS FIG. 2. VIEW OF DESTROYED BOILER FIG. 3. BOILER IN BACKGROUND BLOWN 500 FT.

Part of the salt sheds were wrecked; the boiler house which contained this boiler or battery is a total wreck, and all the smoke stacks about the plant, save 2, were knocked down. One stack on another battery of 2 boilers was left standing and the furnace stack. As a result, the damage to the plant will reach $10,000. The boiler which exploded was the only one under pressure, as the plant was laid off for repairs.

REFRIGERATION

AMMONIA RECEIVERS, EVAPORATORS, BRINE TANKS

By Chas. L. Hubbard

AMMONIA Receivers are usually cylindrical shells, similar in size and construction to oil separators; Fig. 1 shows a common form. In this case the liquid ammonia enters at the top and passes to the evaporator through the pipe at the side, as indicated by the arrows. A gage glass and blowoff are provided, as shown.

Expansion Coil or Evaporator

The form of evaporator depends upon whether the brine system or the direct expansion system is used. In the former system the coil is placed in a tank containing salt brine or a solution of chloride of lime, which becomes cooled by the evaporation of the ammonia in the coils and is then pumped through cooling pipes or coils placed in the space to be cooled. In the direct-expansion system the ammonia is taken directly to the point to be cooled, and there evaporated in pipes or other receptacles in direct contact with the object to be cooled. Each of these systems has its advantages, although the brine system is the older. About twice the cooling surface is required in this case as in the direct-expansion system.

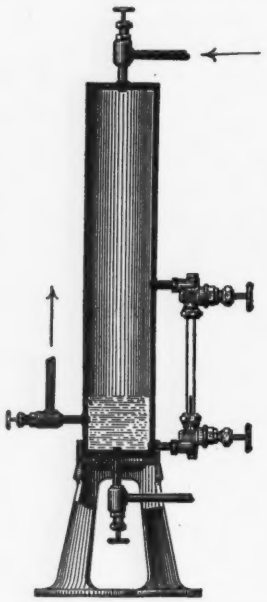


FIG. 1. AMMONIA RECEIVER

Brine Tank

A common form of brine tank and evaporator is shown in Fig. 2, the coil being commonly made up of 1-in. or 1.25-in. pipe bent to the form shown. The liquid ammonia from the receiver enters at the bottom and the gas passes from the top of the coil to the suction pipe of the receiver. The tank itself is made of iron or steel plates from 3/16 to 3/8 in. in thickness. Great care must be taken to make the joints tight against leakage, and the sides must also be well braced or stiffened to prevent bulging.

An insulation about 12 in. in thickness, and consisting of granulated cork, charcoal, dry shavings, sawdust, or other similar material should cover the tank, as shown, to prevent the transmission of heat from the surrounding air to the brine.

Brine tanks are also made cylindrical in form, with concentric coils inside. A compact and efficient arrangement for cooling the brine is that in Fig. 3, which is known as the enclosed-shell type of brine cooler. In this case the brine passes through a series of coils and the ammonia evaporates within the surrounding shell, the whole apparatus having an insulating covering, the same as the regular form of brine tank.

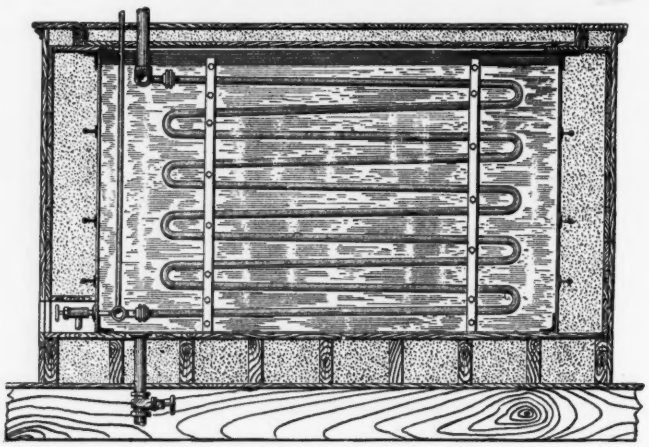


FIG. 2. BRINE TANK

Liquid ammonia is fed into the shell by an ordinary expansion valve near the lower end of the shell at C, and the gas taken off through the pipe D to the compressor. A purge valve, E, for drawing off the impurities is placed at the lowest point in the bottom head, and a second valve, F, at the top for gas and air.

The brine cooler has 2 principal advantages over the regular form of brine tank. First, the brine in passing through the coils is divided into a number of small streams, and is thus mixed and churned so that practically all of it is brought in contact with the cool pipes and gives up more of its heat than in a tank where the movement is very slow. In the latter case, as there is a large body of brine with scarcely any movement, the brine immediately in contact with the pipes may be quite cold, while its temperature rises as the distance from the pipes increases.

The second advantage comes from the fact that there is more space for ebullition or boiling to take place in the shell of the cooler than in the coil in the brine tank, as for condensing. The form is practically the same as that shown in Fig. 4, page 181 of the March issue, the brine passing through the inner pipes and the ammonia being vaporized in the annular space between the 2 pipes.

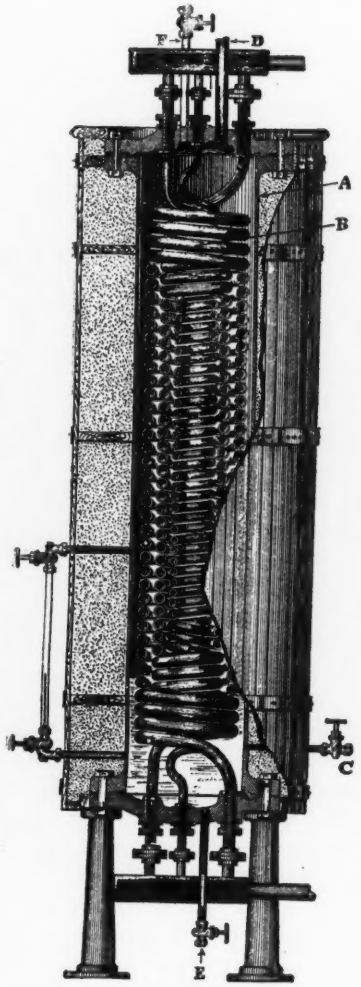


FIG. 3. METHOD OF COOLING BRINE TANK

Figure 4 shows the general arrangement of a compression system of refrigeration, as actually installed. The condenser in this case is of the submerged type similar in appearance to a feed-water heater; the ammonia receiver being at the bottom of the shell. The compressor is shown at the center, with the brine cooler, which is of the enclosed-shell type at the right.

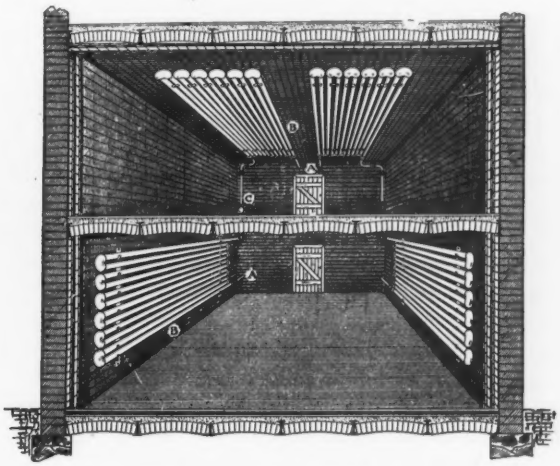


FIG. 5. DIRECT EXPANSION SYSTEM OF COOLING

Direct Expansion

In this case no circulation of brine is used, the vaporizing coils or evaporators being placed directly in the room to be cooled. This system is well adapted to the cooling of cold-storage rooms, and by its use a lower temperature may be obtained than with an intermediate agent, such as brine; this is due to the fact that there

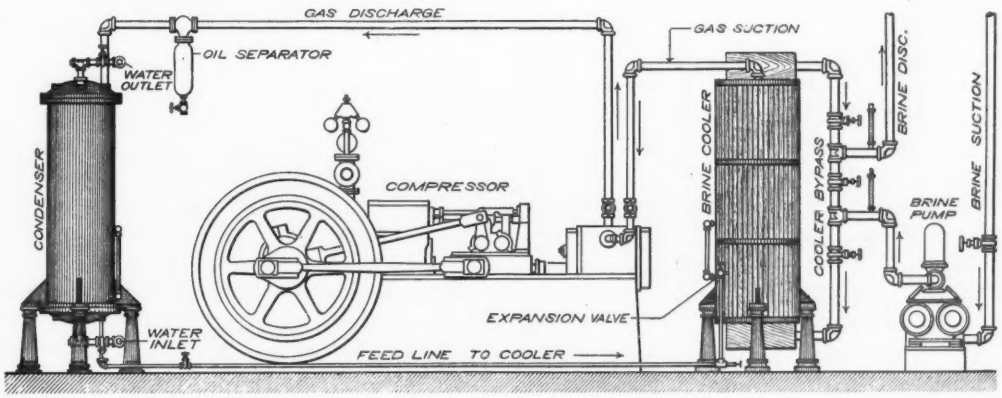


FIG. 4. EXPANSION SYSTEM OF REFRIGERATION

and less liquid ammonia is carried over into the compressor.

The double-coil is also used for brine cooling, as well as for condensing. The form is practically the same as that shown in Fig. 4, page 181 of the March issue, the brine passing through the inner pipes and the ammonia being vaporized in the annular space between the 2 pipes.

must be a difference of from 5 to 10 deg. between the temperatures. Figure 5 shows a common arrangement of the cooling pipes in a system of this kind.

CHARGING AND STARTING AN ABSORPTION ICE MACHINE

By Wm. S. Luckenbach

AS THE time approaches for completing the repairs about an ice plant, the question of charging and starting will be next in order, and the following is one method of charging and starting an absorption machine.

Presuming that all joints have been tightened while cold, and the proper steam pressure is at hand, connect the ammonia pump suction with a drum of aqua ammonia not less than 26 deg. Beaume, and fill the generator, exchanger and absorber to about the center of the top and bottom gage cocks. Now turn on just enough steam to warm up and close the expansion valve, also open the air valves on the top manifold of the cooling and condensing coil; it is advisable to have a man stationed at these valves so as to be ready to close them as soon as the air has been expelled.

When everything, including the condensing coils, is warmed up, start the large water circulating pump slowly, also start the ammonia pump again, pumping from the drum in order to replace with rich liquor the gas that has been liberated in the generator and passed into the condensing coils. By this time there is, possibly, enough pressure in the generator to force the poor liquor into the cooling coils. Now go over all the points and take up all you can, repeating this at intervals until the standard generator pressure has been obtained. Do not force things; take ample time. If you get started, with all the joints tight, in 5 hr. you are doing well.

Continue pumping ammonia from the drum until the poor liquor cooling coils are filled and the ammonia begins to flow into the absorber, which will be noticed by the liquor rising in the gage glass. In the meantime the generator pressure will rise to about 125 lb., and if so, open the expansion valve a trifle so as to allow some of the expanded gas to be absorbed by the poor liquor now flowing into the absorber. Now disconnect the pump from the ammonia drum, connect to the absorber and pump in the usual manner, as there is now about the proper quantity in the machine; some more may be required after a cycle is perfectly established and all entrapped air expelled or burnt off.

There are other methods of charging and putting a newly-erected or repaired plant in operation, but none are more expeditious and thorough than that just described; for instance, the hydraulic pressure test, where water is pumped into the system with the ammonia pump and the joints tested in that manner, after the test, the water is drained as much as possible and steam admitted to the generator coils, sufficient to create a pressure and evaporate or force any water left in the generator, analyzer, rectifier, condenser and expansion coils into the absorber where it can be blown out through the ammonia pump suction pipe. This, however, takes up a great deal of extra time, because after the system is filled with ammonia and heat applied for the liberation of the gas, it would be very unwise not to go over the plant and retighten the joints before starting up for good.

Regulation

After getting the required generator pressure, open the expansion valve a little more at intervals of, say, 15 min., and note the frost on the manifold connected to the expansion coil, and when the frost gets moist under the same pressure and temperature of the liquid ammonia, close the expansion valve a trifle, as the limit of expansion under existing conditions has been reached.

See that the frost on all the expansion coils is about uniform, and if the coils have been connected in sections of 2 or more, as the case may be, to the main manifold (or, better still, have each coil connected separately with top and bottom valves), the regulation of the proper quantity of expanded gas to each coil is easily done. By this time the distilled water, filter and cooler tanks are about full; the air valve on top of the cooler tank must be left open until water flows through it, thus expelling practically all the air, but in order to avoid the possibility of making opaque ice allow water for about one draw to run waste before filling the cans.

Next start the brine agitator to insure a comparatively even temperature throughout the entire bath; the agitation should be just sufficient for that purpose, because any more is a loss of power, and, besides, will increase the temperature of the brine from exposure to the surrounding atmosphere. This is well worth the engineer's careful attention for a few days, until he has the agitator at the proper speed.

When the expanded gas enters the coils at the top, see that the brine is no colder on the surface than at the bottom; the contrary is preferable, because if the cans should freeze solid at the top before they freeze from the bottom up, it would result in either cracked or bulged or bursted cans. The writer has found that by suspending the thermometer about one-third of the distance below the surface of the brine it will register a fairly even temperature of the entire depth.

If the return gas, after passing through the distilled water in the cooler tank on its way to the absorber, continues to frost the pipe heavily, it may be best either to draw an extra can or 2 an hour, or to close the expansion valves a trifle and save steam at the generator, provided there is a surplus of distilled water; the former method, however, is preferable. It is essential that the gas pipe leading from the cooler tank to the absorber be protected from the surrounding atmosphere, as the colder this gas enters the absorber without detriment to either

the freezing or cooler tank the greater is the gain, because there is that much less cooling water required to maintain the normal temperature of the absorber.

Testing as to Capacity

A capacity test after general repairs is absolutely essential; take no chances, do not be over-confident simply because the entire plant has just undergone a general overhauling, only to find when the hot weather is on that some part is deficient, thus either decreasing the output for the entire summer or being compelled to remedy the defect when the demand for ice frequently exceeds the supply. The test proper should not begin until one draw has been made over the entire bath, and the test or output should be from 7 to 12 per cent above the machine's normal rate, the percentage depending upon the general temperature at the time the test is made.

Among the various points to be carefully noted, none exceed in importance the purity of the liquid ammonia, and the method of testing it has been fully described in the November issue. Before deciding, however, on any changes, should excessive moisture in the liquid ammonia be present, verify it by repeating the test in about 5 hr. and carefully note the height of the rich liquor in the generator, because the moisture may have been caused by the liquor in the generator accidentally getting too high; also note the temperature of the waste cooling water from the absorber and compare it with the normal temperature of the absorber, as it may be that the quantity can be reduced and still maintain the same temperature, thus reducing the quantity of cooling water, and also the power required for supplying it. The same care should be exercised at the condensing coils, and for the same reason.

The steam boiler must also be tested relative to the consumption of fuel; also note as to whether all the water flowing into the distilled water tank is condensed steam, or part of it simply boiled water; one method of testing as to purity of the distilled water is explained in a previous article. Use nothing but waste overflow water for loosening the ice in the cans. It is, however, advisable to have a steam line to the dump to be used in case of emergency.

Duties of the Engineer

It is essential that both the day and night engineers be observing at all times, and familiarize themselves with the location and purpose of every joint or valve in the entire plant, and especially on the ammonia system; they will thus naturally become resourceful and be able to act promptly and effectively in case of an accident. The day engineer should see that everything, as nearly as possible, is in good shape when the night engineer takes charge, so that there will be no excuse for an increased temperature in the bath the following morning.

As one engineer turns the charge over to the other he should report any changes made and the results of such changes, so that the one taking charge will know precisely where he stands and govern himself accordingly. Both should work in harmony, having but one object in view, viz., the economical production of first-class artificial ice. By doing this they will command the respect and esteem of everybody they come in contact with by demonstrating their ability for the work that is before them.

FLAT VS. PISTON VALVES

A series of engine tests recently reported by F. W. Dean, mill engineer and architect, Boston, presents excellent opportunity for comparing the economy of engines fitted with flat or with piston valves. The simple engines in the series ranged from 12 by 18 to 16 by 15 in cylinder dimensions. All were of the high speed type and were direct connected to electric generators. All had run for relatively long periods before the tests were made.

Comparison shows that if the load is not considered, the most economical result was obtained with a piston valve engine. This result was, however, obtained when the engine was heavily loaded. But with such lighter loads as were comparable the economy of the flat surpassed that of the piston valve. Moreover, the flat valve engine gave a flatter load curve than the piston valve which is a valuable feature. The most economical results were obtained from an engine which had a flat valve with provision for automatically taking up wear.

On the whole Mr. Dean is led to believe that the flat are more economical than the piston valve engines, if the valves are self-adjusting with wear, and are of a good design. They must have less port surface and less clearance, and can be made to adjust themselves for more wear than piston valves.

The performances of perfectly balanced flat valve engines appear to be so relatively poor, that it seems to disqualify them, unless this type of valve can be made with some mechanism by which wear will not increase leakage.

As showing the comparative cost of boilers and engines over a considerable period of time, Prof. C. H. Benjamin, of Purdue University, gives in Steam the following figures: In 1890 the cost of a 150-hp. horizontal tubular boiler was $1,500 and in 1906 $1,010. For a water-tube boiler the cost in 1890 was $2,700 and in 1906 $1,420. For a 200-hp. engine in the simple high-speed type the cost in 1902 was $1,900 and in 1906 $1,770. The same power in a simple low-speed engine cost in 1902 $3,000 and in 1906 $2,710, and for a compound high-speed engine the cost in 1902 was $4,000, and in 1906 $3,068. These figures are, of course, averages and would be subject to considerable variation in individual cases. The price at the present time would also be considerably different from that given in 1906.

Experiments made by the Pennsylvania Railroad Co. show that when a stream from a hose is turned upon an electric wire, there is practically no danger to those using the hose, even with an alternating current of 2100 volts on the wire, unless the nozzle is within less than 3 ft. of the wire, a condition which is not at all likely to happen.

GAS ENGINES AND PRODUCERS

A NOVEL AIR-COOLED GAS ENGINE

For use about a small shop or for portable work on a truck, it is desirable that an engine should be relieved of the water cooling feature because the piping of water to and from the engine is often inconvenient and, where the engine is to be carried about, getting a water supply is often impossible.

To meet this demand the Jacobson Machine Mfg. Co., of Warren, Pa., has developed its Mascot air-cooled engine, which in general design follows the water-cooled engine built by that company, having the same valve gear, frame and reciprocating parts.

In the cylinder, however, there is a radical departure. The outside of the cylinder is arranged with plain radiating blades having the spaces between them

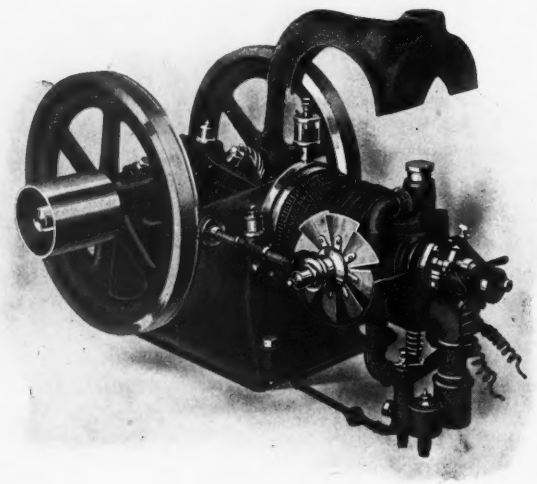


FIG. 1. THE MASCOT AIR-COOLED ENGINE

taken up by a filling of wire coils or expanded metal, which bears on the sides of the blades firmly so as to form good conducting and radiating surface. In this way the actual radiating surface is greatly increased, and to increase still further the cooling effect the whole cylinder is enclosed in a tight-fitting cast-iron jacket, one side of which is in the form of a housing. In this housing is arranged a disk fan so proportioned with regard to pitch and speed that a large volume of air will be forced through the jacket around and between the radiating blades and wire coil filling and will be driven out of 2 longitudinal openings on the opposite side of the jacket. The fan is driven by friction gear from the main shaft to the engine and is on the side of the cylinder opposite the valve gear.

GAS ENGINE PAPERS

AT THE recent meeting of the National Gas Engine Trades Association, several papers of unusual interest were presented, the chief points of which are given in the following abstracts:

IGNITION

By J. A. Williams

IT IS an indisputable fact that the gas engine of today, as far as the engine itself is concerned, is practically perfect; and is not susceptible of any further, great improvement.

There remain, however, 2 very important functions of the gasoline engine which have not been developed up to a stage as perfect as is the engine. These are ignition and carburetion. I have chosen for my subject in this article the subject of ignition. Not that I consider it of any greater importance than that of carburetion, for both are equally important to the successful operation of the engine, but inasmuch as I have devoted several years past to the subject of ignition, and have made of it a thorough study, I feel at the present time more competent to discuss that subject with you than that of carburetion.

The first type of ignition which achieved any commercial success was the old hot tube type with which you are no doubt familiar, and which has almost, if not entirely, been superseded by electric ignition, either of the make and break spark type or of the jump spark type.

The make and break type of ignition is more commonly used on large and slower running engines, while the jump spark type of ignition is more applicable to smaller powered, higher velocity engines.

The reason for this is that the proper mechanical circuit breaking mechanism to operate the igniter points for make and break ignition is extremely difficult to make of sufficiently small size and light weight to render it positive in its action at very high speeds.

The jump spark system of ignition is capable of being successfully operated at very high speeds, as the problems in it are more of an electrical than a mechanical nature.

In other words, the difference between the 2 systems has very often been ably defined as follows: The make and break system of ignition is complicated mechanically but simple electrically and the jump spark system simple mechanically, but complicated electrically.

As to the virtue of either system, both are good, and as far as I have been able to ascertain, equally good, provided that the apparatus and mechanism employed are of

a substantial and satisfactory nature. In either system of electric ignition, the 2 most important factors to be constantly borne in mind are, first, the creation of a spark that is intensely hot; second, the proper timing of the spark.

The timing of the spark in a gas engine is just as important as the proper setting of the valves in a steam engine.

Quality of Spark

On make and break ignition the spark which is created is composed of what is termed dynamic electricity, the heat value of which is estimated by multiplying the voltage across the terminals of the arc or spark by the volume of amperes of current flowing through the spark. The product is the power expressed in watts.

Now this same law applies to the estimation of the heat units of the jump spark, provided that the jump spark is composed of dynamic instead of static electricity.

A great many sparks that are used in jump spark work are static instead of dynamic. The static spark looks white and makes a snappy sound, but will only indifferently ignite the charge in the engine, whereas a jump spark that is composed of dynamic electricity has a reddish appearance, does not have a snappy sound and is intensely hot.

The spark coils that produce either a dynamic jump spark or a static jump spark, look just alike, but the defects in a spark coil which make it produce a static spark are: First, that its windings are improperly proportioned to each other, and to its condenser capacity; second, dampness in the paper insulation of the coil produces a leakage from turn to turn and from layer to layer which forms a partial winding of the coil, the result of which to a large extent neutralizes the self-inductance of the primary winding, consequently permitting the condenser discharge to oscillate at enormous frequencies through the primary winding.

The result of this enormous frequency passing through the primary winding is a static current of high voltage and high frequency in the secondary winding.

A properly designed and constructed spark coil should act simply as a transformer which will transform low voltage dynamic current, but where there are faults in the design or construction of the spark coil, which permit high frequencies to come into play, the spark coil delivers from its secondary winding, static, instead of dynamic, current.

In the design and construction of the spark coil, the object should be to keep the frequency of oscillation down to just as low a point as possible so as to get as pure a dynamic current out of the secondary as possible.

A static spark has not sufficient heat units to explode the mixture in a gas engine properly.

There is no doubt in my mind but that the majority of jump spark coils in use today are delivering not pure dynamic sparks, but largely static sparks. This feature calls to mind the much-discussed question as to which of the 2 sparks, make and break or jump spark, gives to an engine the more power. Some have said make and break and some jump spark. No doubt when a good make and break spark is compared with a poor or static jump spark, the evidence is all in favor of the make and break spark, but in reality if a good hot, dynamic current, jump spark, is compared with the same character of current in a make and break spark no difference will be found in the power developed by the engine with either of the 2 systems of ignition.

The power given to the engine, therefore, does not depend upon what system of electric ignition it has, but does depend entirely upon whether dynamic or static current is used in the spark.

In make and break ignition there is no way to make a static spark, consequently all of the sparks are dynamic.

Timing of Spark

The timing of the spark should be so arranged with reference to the position of the piston or crank that the engine will receive the full force of the explosion at exactly its dead center position or immediately thereafter, as in this position the mixture is at its highest point of compression, and occupies the smallest space. The spark, however, should occur in the cylinder slightly before the dead center position. The amount in advance of the dead center position depending, first, upon the character of the mixture, its homogeneity and chemical composition; secondly, upon the heat of the spark.

For instance, take a mixture that is either of an improper proportion or that is poorly mixed, and it will require more spark advance than a mixture of proper proportions that is homogeneous and well mixed, or a weak spark will require considerably more spark advance to light any mixture than will a hot spark. This lighting of the mixture in advance of the dead center position creates a false compression and a back pressure against the foreward direction of the engine, and therefore causes a considerable loss of power in the engine.

This is one reason why a real, hot spark gives to an engine more power than a weak spark, and is the principal reason, for the hot spark does not start combustion of the charge until the compression stroke is nearly or entirely completed and it propagates ignition through the charge much more rapidly, which has the effect of burning all the gas, thus creating complete combustion when the gas is compressed into its smallest volume, consequently raising it to a higher temperature, giving a greater thrust to the piston of the engine and maintaining its thrust at greater pressure throughout the entire power stroke.

In multiple cylinder gas engines, the timing of the sparks of the different cylinders must be exact. In other words, there must be synchronism or equal time between the occurrence of the spark in the different cylinders. In further explanation, the spark must occur at exactly the same point on the crank shaft circle for every cylinder.

Let us take for example a 3 cylinder engine; should

the explosion occur at exact dead center in cylinder No. 1 and 20 deg. before dead center in No. 2, and 20 deg. after dead center in No. 3, you would have only 1 cylinder giving its full quota of power, namely, cylinder No. 1. Cylinder No. 2 would spend part of its power trying to reverse the engine while cylinder No. 3 would fall 20 deg. short of giving a full power stroke. The above example is by no means an uncommon condition; it seems to be the common rule rather than an exception.

With make and break ignition on multiple cylinder engines, it is rather hard to maintain exact synchronism, owing to the wearing of the igniter points and circuit breaking mechanism.

With jump spark ignition where the timer segments are equally spaced and where a master vibrator is employed to break the circuit for all the coils which spark all of the cylinders, no such difficulty is encountered, but exact synchronism is established and maintained all of the time between all of the cylinders. Where a master vibrator is not employed it is a difficult matter to adjust the vibrators of the different coils so as to get exact synchronism.

It is possible, however, to build spark coils which will synchronize without a master vibrator. In other words, coils which are auto-synchronous, no matter how their vibrators are adjusted. An auto-synchronous coil should be wound so as to have a very quick time constant. The vibrator springs should be so proportioned that increased tension on the vibrator spring brings into action a correspondingly increased amount of magnetic attraction to the vibrator tongue or armature, the one exactly offsetting the other, with either an increasing or a decreasing vibrator tension.

Current Sources

There are 2 sources of electric current for ignition; one is the magneto, which generates a current by mechanical means, the other is a battery, either dry, wet or storage, which generates current by chemical means.

There are 3 types of magneto ignition. The most recent type is the inductor type, which has no moving wires, commutators or brushes and which generates a sine wave of alternating current. The second is a dynamo type which has a commutator and brushes and a little drum wound armature and which has a permanent magnetic field. This type of magneto is merely a dynamo with permanent magnets instead of electromagnets for its field. The third type of magneto, and one which will not be described in this paper, is an alternating current magneto, which is equipped with its own circuit breaker and distributor, and which is commonly called a high tension magneto.

In this article we will refer to magneto ignition as used on the make and break system of ignition, and on the jump spark system of ignition where a timer and vibrating spark coil is used.

The magneto system of ignition is, of course, more expensive in first cost, but if a properly designed and constructed magneto is used, there is no appreciable maintenance charge on the ignition system.

If batteries are used, while the first cost of the installation is lower, the maintenance charge begins with the starting up of the engine and never stops as long as the engine is in use.

On make and break ignition there is a decided reason for using magneto ignition over battery ignition, for with a properly designed and constructed magneto, the igniter points in the cylinder of the engine last indefinitely, and they can be made of cheap material, such as steel, or German silver, for the voltage which the magneto delivers is sufficiently high to overcome any ordinary resistance, such as oxidized or dirty points; whereas the ordinary battery which delivers from 4 to 6 volts for make and break ignition, requires clean contact points, and of a metal which will not oxidize, for if the resistance of the points is too high there is not sufficient voltage in the battery to charge the coil.

The Magneto

The dynamo type of magneto which has a commutator and brushes and governor and which operates through means of the ordinary kick coil just as batteries do, is no better in this respect than batteries.

The proper magneto to use for make and break ignition is the inductor type, which requires no coil of any kind, as the winding on the magneto itself acts as a kick coil so that when the circuit is broken the e. m. f. across the igniter points will range very close to 700 volts, according to winding of the magneto and its speed, although the amperage or volume of current will be comparatively small.

With battery or ordinary dynamo type magneto the first voltage, that is, that used in charging the primary or kick coil, is necessarily extremely low, from 4 to 6 volts, and voltage across the points when they break is about 60. Now, assuming that both sparks have the same amount of energy, the one from battery or dynamo type of magneto would have 10 times the current and 10 times the destructive effect upon the igniter points of the engine, than the inductor type of magneto would. It is not voltage that burns out points, but it is the amperage or volume of current.

The inductor type magnetos that I am most familiar with have a primary or first voltage of about 70 volts, which is ample to go through any set of igniter points, no matter how burned, pitted or oxidized they may be, and as this is multiplied about 10 times by the breaking apart of the igniter points, there is about 700 volts with a consequently small amount of amperage thrown across the igniter points as they separate.

An additional advantage of the inductor type of magneto over the dynamo type for make and break ignition is, that the inductor type can be positively gear-driven at crank shaft speed for engines of 1, 2 and 4 cylinders, and at one and one-half times crank shaft speed, for engines of 3 and 6 cylinders.

The inductor type magneto has the further advantage

of passing current through the igniter points in a much smaller interval of time than is taken by a battery or dynamo type of magneto to charge a primary coil, therefore the circuit breaking mechanism on the engine can be so constructed as to close the circuit for a small interval of time, thus taking up a lot of the lag in the circuit breaking mechanism.

Now when using a primary or kick coil with battery or dynamo type magneto, it takes such a long time for the primary coil to become charged with current that the circuit breaking mechanism on the engine has to keep the contact points together for a considerable period of time in order to charge the coil, and then when the tripping mechanism operates, the circuit breaker has to swing through a long arc of its travel before it breaks the contacts apart, thus causing a considerable lag to the circuit breaker.

The inductor type magneto permits of the use of a circuit breaker for make and break spark which will operate the engine at speeds fully as high as any jump spark system could operate under.

Spark Coils

Speaking of jump spark ignition the most important factor in the apparatus is the spark coil. The spark coil looks like a very simple piece of apparatus, but there is enough electrical science employed in the construction of a first-class spark coil to fill volumes in describing it.

All that we can say about it here is that it must be so designed and built as to produce a dynamic instead of a static spark. It must have a quick time constant permitting it to operate on timers of very short segments, thus economizing battery current. Furthermore, it should have a vibrator constructed with reference to the time constant of the coil and so constructed that a careless user could not possibly adjust the vibrators so as to make the coil take more current than its insulation would withstand.

Soft platinum points should not be used, but an alloy of such a percentage of iridium and platinum as will permit very hard and dense points which will not weld together as soon as they warm up. It must be borne in mind that pure platinum is a soft and spongy metal which has a temperature extremely low for welding heat.

Iridio-platinum contact points stand a much higher temperature before they will weld or seize together.

In the construction of spark coils the very best of insulating material should be employed, and after the windings are made they should be pumped out in a hot vacuum, thus exhausting all the air and moisture and they should then be impregnated, while under vacuum, with a dielectric of heat and moisture-resisting qualities, which will seal up the windings, making them impervious to moisture and preventing all electrical discharges and leakage between its turns and layers.

This method of treating spark coils is quite recent, and is by no means as yet universal among the various spark coil builders. If spark coils were all built properly with the proper kind of windings and the proper kind of vibrators used, and the coils used in connection with the proper kind of timers, that is, timers which do not have an unnecessarily long period of contact, it would be found that the battery consumption could be reduced very materially.

Many people seem inclined to blame their batteries for all their troubles, whereas if the truth was known, the fault, in a great many instances, is in the quality of the spark coil used and not in the batteries.

Current for Jump Spark

As to source of current for jump spark ignition there are 2 kinds of magnetos which may be employed, also battery ignition can be employed. The dynamo type of magneto with commutator and brushes and governors is no better, so far as the power given to the engine is concerned, than are batteries.

The inductor type alternating current magneto, the voltage of which increases directly as the engine speed increases, gives a much hotter spark at normal rates of engine speed than either the dynamo type of magneto with governor, which has a fixed voltage, owing to its having a fixed speed controlled by governor, or a battery, which we know has a fixed and nonincreasable voltage.

The reason that increased voltage is required as the engine increases in speed is because the timer contact points in passing over each other rapidly do not come into as intimate electrical contact with each other as when the engine is running slow, consequently the resistance of the timer increases directly in proportion to the speed of the engine, and as the voltage of battery or dynamo type magneto does not increase to meet this increased resistance of the timer, the battery, or dynamo type magneto spark consequently gets weaker as the engine speeds up on account of this added resistance in the primary circuit.

It is therefore evident that a source of electrical current, the voltage of which can be increased automatically as the engine increases in speed, is the best source of current for operating a jump spark system of ignition which employs the ordinary timer and vibrating coil.

In the discussion, replying to questions Mr. Williams stated that color and sound are the best means of telling the 2 kinds of sparks. The dynamic spark is yellow and hisses rather than crackles; it has heat in it and will quickly set wood or cardboard on fire. The static spark is bluish, crackles loudly and has no heat. As to use in high compressions, he stated that he had seen the jump spark used successfully under 140 lb. compression; the higher the compression the longer the jump to be used, about 20,000 volts being required to the inch of jump for a dynamic spark; the current is probably not over 0.001 ampere.

Connection of Batteries

The paper by Mr. Haskell on Connection of Batteries gave facts in regard to the system described on p. 174 of the March issue. As to the drain on different series which are connected in parallel, Mr. Haskell stated that

it would be practically the same, but there is a question whether the same results could not be had by using large cells rather than series of small cells in parallel. Dry batteries shoud be put into service within 60 days of manufacture, because of running down when standing in stock.

Rating of Engines

C. O. Hamilton advocated rating gas engines at 80 per cent of their best capacity and guaranteeing them to pull 25 per cent overload rather than rating at full horsepower which they can pull.

There was lively discussion, some claiming that the rating of engines as now sold is satisfactory, others that most of the trouble is due to ignorance or carelessness of the purchasers, still others that dealers and agents sell engines for a higher power than the builders' rating.

Mr. Linn spoke of the need of getting data as to performance under variable load and fuel consumption at half and quarter load; also of piston speed, cylinder displacement and other matters that affect economy.

Information About Engines

George Cormack, Jr., in a bright and snappy paper advanced the thought that in education lies the solution of many gas engine troubles. To get the operator to understand his engine and give it intelligent care. Also to train the salesman so that he will devote himself to intelligent explanation of the mechanical principles and advantages of his engine, rather than to mud-slinging. And to provide trouble experts who are real experts.

IMPORTANT POINTS

WITH everything in shipshape a gas engine may run along for weeks with no difficulty whatever and in such a case if the plant is of the suction producer type there is little for the attendants to do except to see that bearings are properly oiled. The tendency is for whoever is in charge of the plant to be careless about keeping up the engine and this will soon or later result in a stoppage with great or less inconvenience.

Points which must be looked after in order to keep a plant running steadily are that the gas shall be at a constant pressure so that the mixture with air will be always the same. To ascertain this a U tube, such as is used for a boiler draft gage, is the most convenient instrument. This would show at all times the amount of draft or pressure in the gas main leading to the engine.

Gas must be always at uniform temperature as otherwise the density of the charge will be affected and this will also change the quality of the mixture, a high temperature giving a mixture of poorer quality than a low temperature. Gas must also be kept clean as otherwise there will be cutting of the cylinder and clogging of the valves. Even with gas kept at constant pressure and temperature and clean, more or less reguation of the mixture will be required because of the change in the density of the air and of the temperature outdoors. This regulation can be readiy accomplished but must be watched to be certain that it is made when necessary.

Valves must be inspected from time to time to see that they fit their seats properly and that the spindles are working freely, also piston rings must be kept in good working condition to prevent leakage both in compression and during the working stroke.

Timing of the ignition is an important point, as a wrong timing results in a considerable loss of power and of violent strains on the engine with possibilities of breakage. Governing must be accurate, which means that the governing mechanism must be kept clean, oiled and properly adjusted.

All this means simply that in caring for a combustion engine the same watchfulness and attention to details should be given it as would be given to a steam engine and that this attention must be given by an experienced, skilled man who knows what he is about, who understands the principles of the combustion engine and its mechanism.

ACTIVITY IN GAS ENGINE BUILDING

Contracts for gas engines and electric generators direct connected are being let with considerable rapidity, the rapidity increasing as the merits of this method of generating become known and the reliability is proved. The Pittsburg Plate Glass Co. has ordered for its Crystal City, Mo., 2 alternating-current generators of 3000 kw. combined capacity, each driven by 34 by 38-inch. horizontal twin-tandem Allis-Chalmers gas engines.

These are to run at a speed of 127 r. p. m. and each unit will weigh about 1,000,000 lb., the flywheel alone weighing 120,000 lb. The 2 units will operate in parallel and are designed to carry full load at 85 per cent power factor, delivering 3-phase currents at 25 cycles and 2300 volts. Gas to drive them will be furnished by producers. The same company has bought for its plant at Kokomo, Ind., 3 similar units, each having a capacity of 725 kw.

In the power plant of the Kansas Buff Brick & Mfg. Co. will be installed 2 horizontal tandem gas engines, one of 500, the other of 250 hp., to operate on natural gas. They will be connected through friction couplings on the ends of the crank shafts to a common transmission shaft from which a belt wheel will drive to a 150-kw. Allis-Chalmers generator. On the 500-hp. engine will be a belt wheel to give power to the line shafting in the brick factory. Other contracts pending for gas engines and generators to be purchased from the Allis-Chalmers Co. involve not less than 30,000 hp.

"WHILE A CONCRETE FOUNDATION is still soft take two pieces of timber 4 by 4 in. and long enough to go from one foundation bolt to another, lengthways of the foundation, allowing 3 in. over at each end. Push both of these down into the foundation until the tops are even with the surface. Lay a spirit level across these pieces at both ends, and no trouble will be had in leveling up the machine. Both the 4 by 4 pieces should be placed inside the foundation bolts."

COUNTERBALANCING OF STEAM ENGINES

By F. H. Ball

EFFECT of a counterbalance attached to the heel of a steam engine crank opposite the crank pin, and the fixed limitation of the influence of the counterweight are subjects not generally understood. For instance, many suppose that an engine may be perfectly counterbalanced at 1 speed and not so at another, which is not true. The whole thing is, however, easily calculated and not difficult to understand.

The centrifugal force of a counterweight acts on a radial line directly opposite the crank pin and, when the crank pin is passing the line of the reciprocating parts or the "center," the counterweight opposes or neutralizes

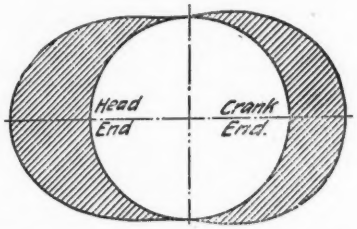


FIG. 1. EFFECT OF UNBALANCED RADIAL FORCES FOR A SIMPLE HORIZONTAL ENGINE WITHOUT COUNTERWEIGHTS

the unbalanced force due to the starting and stopping of the reciprocating parts.

If there were nothing else to be considered except the counterbalancing of the reciprocating parts at the center where the greatest need of counterbalance is felt, the problem would be a very simple one, for it would be necessary only to determine how much counterweight would exactly neutralize the unbalanced force at the centers and the engine would be perfectly balanced. Unfortunately, the problem is a more complicated one for 2 reasons:

Difficulty of Balancing

First, because of the angularity of the connecting rod, the rate of acceleration of the reciprocating parts is much greater when passing one center than the other, therefore a counterweight that exactly neutralizes the unbalanced force at one center is too heavy or too light, as the case may be, at the other center. The effect of a connecting rod of the usual length is to increase the force at one center about 1/6 and reduce the force at the other center the same amount, thereby making a difference of about 1/3 between the smaller and the larger force. This is inevitable, and it is plainly impossible to perfectly counterbalance an engine, even on the line of centers, unless a connecting rod of infinite length is used.

This is not all, and, in fact, "the worst is yet to come," for the counterweight exerts its full force radially at all positions in the revolution of the shaft, and when in a horizontal engine, the counterweight is in a position above or below the shaft, there are no reciprocating parts developing an equivalent force in the opposite direction, so that the centrifugal force of the counterweight causes a violent unbalanced up or down force.

This is illustrated by the fact which has been established by experiment, that the counterweight on the driving wheels of locomotives actually causes the wheels to lift from the rails at every revolution when the speed is very high. A clear idea of these forces may be had by investigating, for instance, the counterbalancing of a 16 by 14-in. simple American Ball engine, rated at 160 hp. and running at 250 r. p. m.

The reciprocating parts of this engine, consisting of

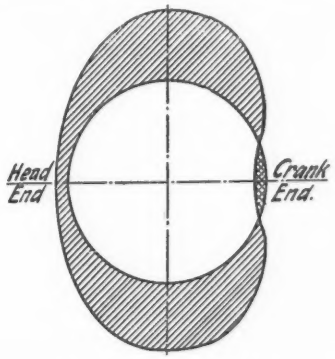


FIG. 2. UNBALANCED RADIAL FORCES FOR A SIMPLE HORIZONTAL ENGINE WITH COUNTERWEIGHT

the piston and rod, the crosshead and the connecting rod, weigh about 550 lb. These parts, because of their inertia, develop an unbalanced thrust when the crank is passing its center, of about 6900 lb. which is exactly equal to the centrifugal force of a mass of 550 lb. revolving on the shaft and having its center of gravity 7 in. from the center of the shaft.

Figure 1 would represent the inertia force of the reciprocating parts of this engine, if no counterbalance were used. The length of that part of a radial line lying within the shaded area would represent the unbalanced force at every instant of a complete revolution. It will be seen that the greatest unbalanced force would be on the line of centers. The modifying effect of a connecting rod is also apparent in the difference between the maximum forces at the 2 centers. It will be noticed that near midstroke there is no unbalanced force because the reciprocating parts have at these points their maximum velocity and no inertia force is felt until there is a change of velocity.

Effect of Counterbalance Weight

Now, a counterbalance weighing 550 lb. attached to the heel of the crank, with its center of gravity located 7 in. from the center of the shaft, and directly opposite the crank pin, would neutralize or counterbalance the inertia thrust of the reciprocating parts when passing the line of centers of the engine.

Figure 2 represents the inertia forces under these conditions and may be considered typical for all single horizontal engines. It will be noticed that the effect of the counterweight is to transfer the maximum unbalanced force into a vertical direction without any diminution in magnitude, so that the maximum forces are not neutralized, but are merely transferred from horizontal to vertical. It will also be noticed that because of the modification due to the connecting rod, a small unbalanced force is still felt on the line of horizontal centers, but instead of being a reciprocating force it is directed toward the cylinder at both centers. This is brought about by the

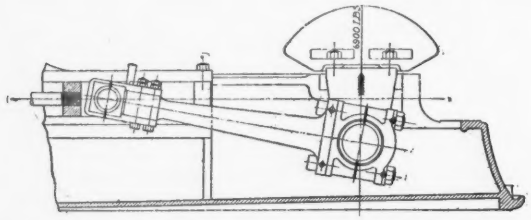


FIG. 3. VERTICAL THRUST EFFECT DUE TO COUNTERWEIGHT

fact that when the crank is passing the center toward the cylinder the acceleration of the reciprocating parts is too great for the counterbalance, hence an unbalanced force toward the cylinder is developed by these parts; while at the opposite center the acceleration of the reciprocating parts is too little for the counterbalance, hence an excess of centrifugal force produces an unbalanced force toward the cylinder also.

While this constitutes good counterbalance at the point of otherwise maximum unbalanced thrust in a single horizontal engine, and while it would eliminate any tendency

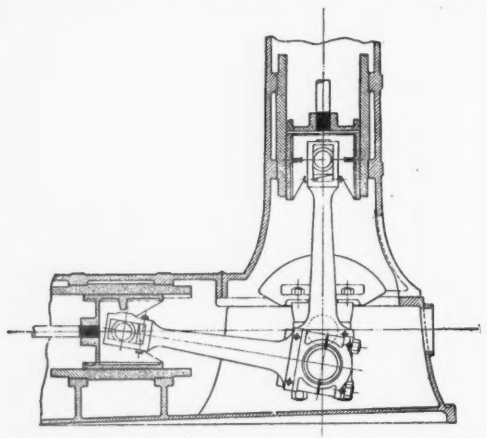


FIG. 4. ARRANGEMENT OF THE ANGLE-COMPOUND ENGINE

to shake horizontally on the foundations, it is very apparent that if there was nothing to neutralize this thrust of about 3.5 tons, the engine and foundation would tend to hop up and down 250 times a minute.

The 6900 lb. of centrifugal force of the counterweight is a constant force and always exerted on a radial line outward from the center of the shaft. Thus in the position of the crank shown in Fig. 3 the direction of this force is on a vertical line, as indicated by the arrow. The only opposite force in this position of the parts is the centrifugal force of that part of the connecting rod that develops centrifugal force on the crank pin. The opposing of these centrifugal forces at this point leaves an excess of about 6,000 lb. in the direction of the arrow, which same 6,000 lb. is felt in a downward direction when the counterbalance passes the lowest point, so that the counterbalancing of the reciprocating parts in a horizontal plane has developed a reciprocating vertical thrust of about 6,000 lb., which alternates vertically in its direction 250 times a minute.

Perfect Balancing

A practical method of correcting this fault of a reciprocating engine is to combine 2 engines on the same crank pin having the high-pressure and low-pressure elements at 90 deg. from each other in the plane of the crank rotation, as in the American Ball Angle Compound engine, for in this way the fault of each engine is made to neutralize the same fault in the other.

Figure 4, a partial cross-section, illustrates this ar-

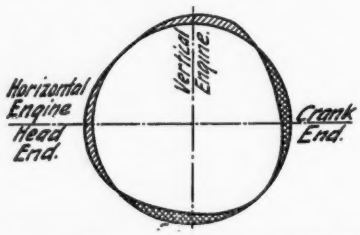


FIG. 5. UNBALANCED RADIAL FORCES WITH 90 DEGREE ARRANGEMENT OF CYLINDERS BALANCED AS SHOWN IN FIG. 4

rangement. The horizontal engine is arranged to be perfectly counterbalanced on its line of centers, but as has been explained, is badly out of balance in a vertical plane. The vertical engine is balanced in its vertical line of centers, but if considered apart from the horizontal engine is badly out of balance horizontally. The relation of these engines to each other is such that the same counterbalance serves perfectly for both engines. The crank in Fig. 4 is shown in the same position as in Fig. 3, and the heavy vertical thrust due to the centrifugal force of the counterweight is neutralized by the inertia of the vertical reciprocating parts. The same balancing occurs again when the crank has advanced 90 deg. to the line of horizontal centers, only in this case the horizontal engine, instead of the vertical, is balanced by the counterweight, so that at 4 points in each revolution the counterbalancing is perfect, and between these points the overlapping of the forces of the 2 reciprocating parts maintains approximately a perfect balance.

Figure 5 is a diagram of the unbalanced inertia forces in such an engine, having a counterbalance of sufficient weight to neutralize the mean inertia force of the reciprocating parts of either engine on its line of centers. The slight unbalanced forces are due to the effect of the connecting rods.

SCALING A CHIMNEY SHAFT

THE fixing of scaling gear to a large chimney stack is an interesting operation, which doubtless many have had the opportunity of witnessing. Of the several methods in use the one known technically as "laddering" is considered the best all round, and is the one most commonly used. In this system a series of ladders are strung together in an unbroken line to the side of the stack wall. The size of ladders used is usually about 16 ft. in length. The top end of each ladder is provided with notches and the foot fitted with iron adapters or sockets, as shown in the sketch, Fig. 1. Wood distance pieces or blocks are used to keep the ladders at a suitable distance from the stack wall.

The steeple-jack chooses a good day, and if the part to be inspected, say, damaged lightning conductor, is visible to the eye when viewed from the ground level, that side of the stack is marked out for laddering. A couple of distance feet having been fixed the first scaling ladder is held upright against the stack wall by the steeple-jack's mate (laddering is generally a 2-handed job) and a holdfast of the form shown in Fig. 2 is driven over its bottom rung and anchored by a short piece of rope. The steeple-jack, grasping hammer, holdfasts and rope, mounts the ladder and secures the top rung in the same manner as the bottom one.

Signalling by a sharp whistle to his mate, the latter passes up a single sheave block and tackle, which the steeple-jack hooks on to the last fixed holdfast. A light signalling line is also passed up, one end of which the steeple-jack makes secure about his waist, the free end being allowed to fall to the mate below. The next ladder, No. 2, is hauled up by the mate and lashed half-way high to No. 1 ladder.

Climbing No. 2, the steeple-jack drives in a holdfast, hooks the block thereto, and, descending to the first ladder, unlashes the rope holding the 2 ladders together. A jerk on the signalling line, and the second ladder is hauled up, hung on the holdfast, then adjusted on its adapters with the notched ends of the first ladder, and finally its bottom rung is anchored to the holdfast with a short rope lashing. In this manner the work of scaling proceeds until the coping or thereabouts, is nearly reached.

Here the steeple-jack finds a ring of masonry or string-coursing outstanding a considerable distance from the wall face, which has to be negotiated before he can reach the coping proper. A change is now made in the modus operandi of working. The next ladder is hooked to a rung above its middle and hauled up by the mate, the block remaining on the top holdfast of the last fixed ladder. In this position the 2 ladders are securely lashed together about the middle, rather more time being taken over this point by the steeple-jack.

One feels a series of cold shivers chase up and down the spinal column as the steeple jack mounts the overhanging ladder, still unsecured at its top end, and with one arm embracing the ladder and at the same time grasping a holdfast, proceeds to unite it with the top rung, finally anchoring with rope lashing. One more ladder, a "baby" this time, tops the chimney stack coping stone.

The return journey is occupied in the testing of joints, etc., and may not be quite as interesting to the spectator.

The job, from start to finish, including a brief inspection of the corona, has taken a trifle over 2 hr. Evidently there will not be much need for the steeple-jack to draw on his imagination in making up his time-sheet.—The Engineer in Charge.

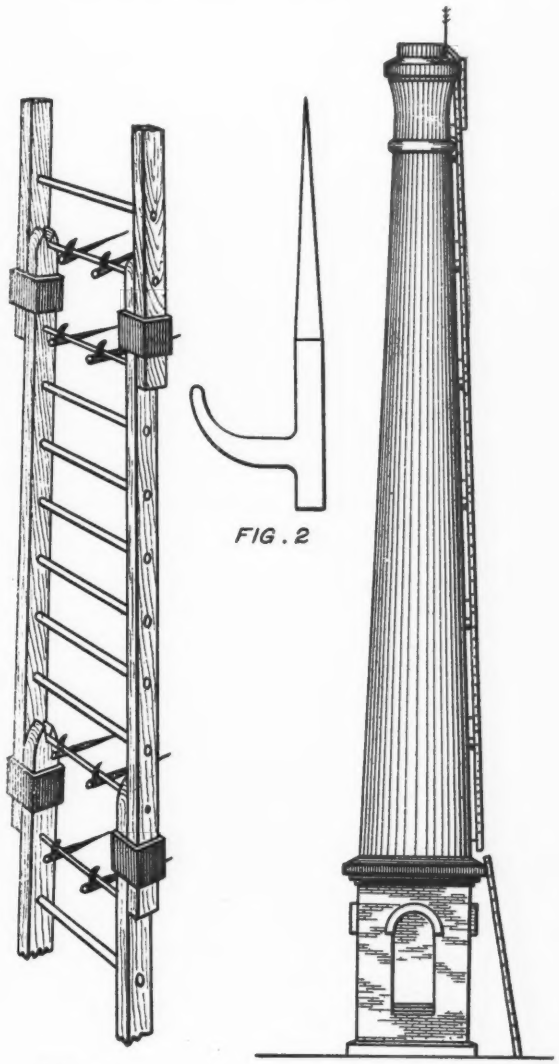


FIG. 1. SCALING LADDER FOR CHIMNEYS
FIG. 2. HOLDFAST FOR ANCHORING LADDER
FIG. 3. THE CHIMNEY COMPLETELY "LADDERED"

LETTERS FROM ENGINEERS

Send us descriptions of ways of doing new things, and new ways of doing old things. Rough pencil sketches and letters are all right; we will fix them up for the printer. All accepted contributions will be paid for when published.

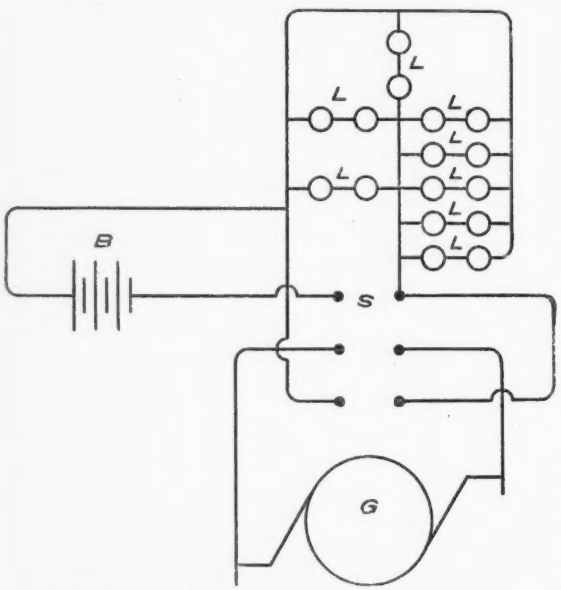
Charging Low Voltage Batteries

In your December issue on page 64 W. E. C. wants to know how to construct a suitable resistance to charge his storage batteries from a line voltage of 250, the voltage required by the battery being 6 volts.

I have at the present time 3 ignition storage batteries that appear to be nearly the same as those of W. E. C. They are stamped 6 volts, 15 ampere hours, and I charge them from a line carrying 110 volts.

Each battery is in series with a 16-c. p., 110-volt lamp, and the charging is carried on about ½ the time that the batteries are in use.

I intend to change to 8-c. p. lamps and then charge all the time. I think if I were W. E. C. I would connect the battery as shown in the sketch. Where G is the generator, L 125-volt lamps, B the battery, and S a double-pole double-throw switch. When the blades



CONNECTIONS FOR CHARGING STORAGE BATTERY

are on the upper contacts the battery is being charged through the lamps, while when on the lower contacts the lamps burn without charging the battery.

I would arrange the lamps in the engine room so as to distribute the light as wanted, for in this way there would be no waste of current when charging in the evening or on dark days. It will be noticed that there are 2 125-volt lamps in series.

Should W. E. C. have any doubt about the above way of connecting up the battery he could submit the plan to the makers, who would be glad to give him any information he desired. G. H. B.

Connecting a Steam Radiator

You will find enclosed 2 sketches showing methods of connecting up steam radiators, upon which I would like to know the opinion of others who have had ex-

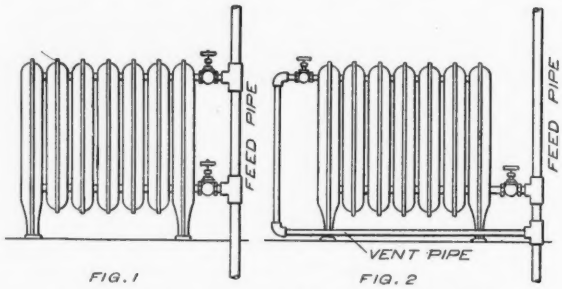


FIG. 1. VENT PIPE CONNECTED BELOW INLET
FIG. 2. VENT PIPE CONNECTED ABOVE INLET

perience in this line. Should the vent pipe be attached to the feed line above or below the inlet pipe?

Wm. L. H.

Station Responsibility

In the February issue W. G. B. asks for opinions on the relative responsibility of the operating engineer and the switchboard operator in a power plant. In the following issue Mr. Kahl answers the question from the engineer's point of view, but those who have had experience with the inside working of a large plant will hardly agree with his statements.

The duties of the engineer begin where the coal is delivered to the building, and he is in charge of the operation up to the point of delivering the energy to the generators. The operator's responsibility extends from the point where the cables leave the building back to where the engineer's responsibility leaves off. It is at this dividing line that the conflict usually occurs.

The object of a central station is to supply electric current to the connected load at proper voltage and in a manner which will give absolutely reliable service. The switchboard operator is completely in touch with the electrical situation; he knows what kind and size of a load to expect on different nights and under different conditions. He must use his judgment as to the number of units he wants and time of starting and stopping, he should even have his choice of units, since each engine has its peculiarities, such as ability to carry overload steady, easier to parallel, better insulation, tapping in at a more desirable point on the bus, etc.

It is quite customary in large plants at the beginning of each watch for the engineer and the operator to arrange for additional units, so that the operator knows what to depend on and the engineer what to have ready. The many emergencies which come up in a large plant require quick and careful decisions on the part of the operator. Difficulty in holding steam, a short-circuit or ground, overload, thunder storms, severe pumping, loss of condension, are some of the most frequent. The duties of the operator are to maintain proper voltage, frequency and power-factor, proper division of the load on units, and the proper number in service, keep in touch with substations, take instrument readings, keep records and reports, make tests, note proper working and adjustments of apparatus, and be ready for trouble.

The switch board is the vital part of the plant, and requires more skill and judgment than any other part. They are frequently large and complicated, and usually located in a gallery or commanding position where the switchboard operator or system operator, as he is sometimes called, can overlook the entire plant.

Without wishing to underrate the position of engineer, I believe his position is in the engine room and his duties to produce the motive power as cheaply as he can, consistent with the electrical requirements. The fact that he is in charge of the prime-movers does not signify that he is in charge of any more of the operating force than is engaged in generating steam and handling the prime-movers and auxiliaries.

The experience of the writer for a number of years on one of the largest boards in New York City, where the operator ranks first, demonstrates that any subordination of the operator would have caused confusion and unreliable service. Lewis C. Reynolds.

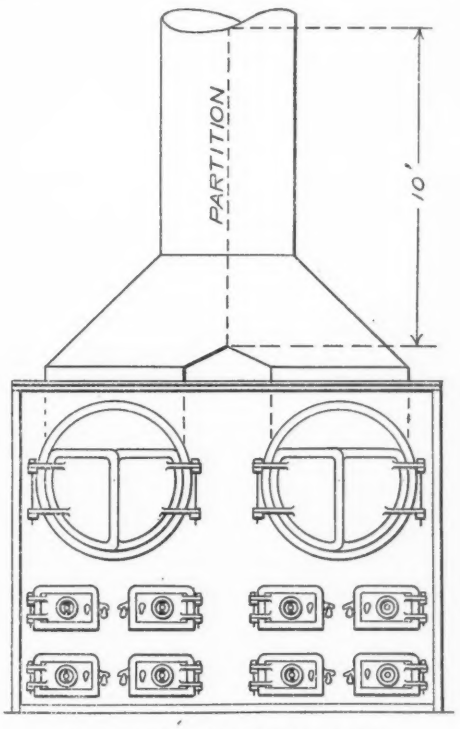
Equalizing Draft

Stack trouble will, I think, be avoided by putting a partition in a stack which serves 2 boilers, making the partition about 10 ft. high and solid, so that 1 boiler cannot rob the other of its draft when the fire in one is being forced harder than in the other. The enclosed sketch shows my idea. Wm. Rommel.

The Need of Study

The article in the February issue by S. J. K., under the above title, hits the nail squarely on the head and I hope it will be the means of "bringing at least one erring brother to salvation," as the old deacons used to say. You will notice that the man who is all the time growling about not getting ahead, that the firm that he works for don't give him any show, and that the examiners are in league to prevent him from getting a better grade of license, is of just the class mentioned by S. J. K. They have plenty of time to read the account of the latest fistic battle or of some notorious, dirty, unwritten law murder trial, but not to read the paper that is published for their especial benefit.

Any paper is valuable to its subscribers who read it, advertisements and all. Some do look over the reading matter and kick about the advertising part. "Too many advertisements." If they but knew it, that department is as interesting and valuable as the rest. Not long ago I had an engineer come to me for the address of a firm that carries a large advertising space in this very paper. He spent 30 ct. carfare and 2 hr. or more time to find out something that he could have learned in 2 min. by looking over the advertising pages of his paper. I made some pointed remarks to him about it, and he promised to mend his ways.



STACK FOR EQUALIZING DRAFT

I subscribe to 2 monthlies and 1 weekly paper and there is nothing in them that escapes my notice. All the important articles I have catalogued. Small tables, rules, formulas, etc., are copied into a book which I keep in my desk in the engine room, so that if anything comes up I know just the way to solve the problem in the quickest and best way. I don't know if I am an exception, but it is very hard for me to memorize rules and formulas, so when I run across anything of the kind that I consider is, or will be, of any use to me, I just put it away where it can be found at a moment's notice.

I keep all my papers on file in an accessible place and I find great pleasure in reading the back numbers of 20 or 25 yr. ago and comparing the practice and equipment as it was then, and at the present time. It is wonderful what an immense improvement has been made. Look back, ye old gray-headed codgers, and think for a moment what you would do if you were back there again.

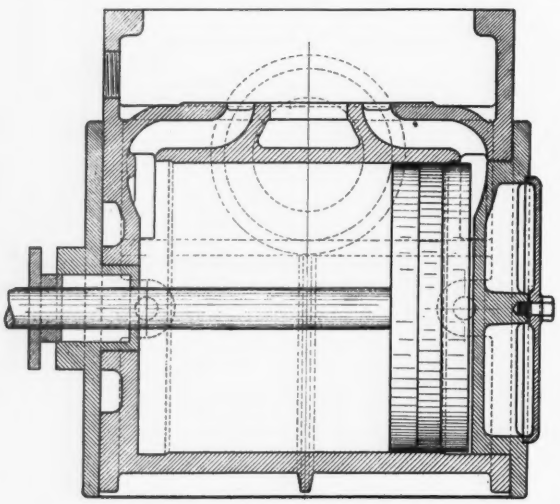
The only salvation for the young engineer or fireman of today is to read and study, that is, if he ever wants or expects to be any better off than he is today. Wishing

won't accomplish anything. Get down and dig. If an engineer will read carefully and digest the contents, advertisements and all of this paper for a year he will have a fund of knowledge that dollars could not buy.

An old schoolmaster who taught me when I was a boy told us scholars that our minds were like a cupboard with numerous shelves for the storing of such knowledge as we might acquire and when placed there in an orderly manner was ever ready for instant use, and that it was our duty to fill it full. I always thought it was good advice, so I will pass it along. W. E. S.

Poor Cylinder Design

As an example of how defects in design occasionally escape detection until a machine is put in operation, the accompanying sketch of a cylinder and piston for an



A POORLY DESIGNED CYLINDER

18 by 16-in. high-speed horizontal engine is an interesting case. On starting the engine the first trouble encountered was the impossibility of attaining the required speed. As the crosshead shoes were cast iron and cut into the guides badly, although lubrication was good and the pressure on the guides not excessive, it was thought that babbitting the shoes might remedy the defect.

This was done and the engine brought to speed, when it began to pound badly at both ends of the cylinder. As the piston was fitted with a single ring, as shown, it had to overrun the counterbore of the cylinder 1 13/16 in. to give an overtravel of the ring of 1/16 in., but the main defect was the fact that the piston also overran the steam port by ¾ in. at each end. This was the cause of the trouble, for the piston being 1/32 in. smaller than the cylinder and having such a large part of its side directly in the path of the entering steam, was of course forced violently against the opposite wall of the cylinder at each end of the stroke.

Soft metal strips were put in the piston on each side of the ring and then turned to the cylinder diameter, but as might be expected they were of no value, for as soon as they passed the counterbore the conditions were the same as before. Wide babbitt strips extending to within ¼ in. of the ring were next tried, but of course the results were the same.

The cylinder was then rebored, a liner fitted and bored, but the counter bore not carried in so deep. This helped matters some and as the engine was needed it was shipped in this condition, but there is no overtravel of the ring on the cylinder and consequently there is a tendency to wear shoulders at the ends. It is probable that a double ring piston would have been still better, but the fact is emphasized that the amount which a piston overruns a steam port must be small if good results are expected. H. L. Dean.

Loss From Pipe Bends

G. M. C. illustrates 3 methods of pipe turn in the December issue and asks: "Which of the 3 methods of piping shown is the most practical, also what is the per cent loss in each case by condensation of steam passing the elbow, tee and curve?"

As for the practicability of the different methods shown, it is about the same in all 3 cases, unless he figures on future changes at or near the turn, in which case either the first or second method would be more practicable than the third on account of the ease with which the change could be made.

The first is the cheapest to install, then follows the second and third in consecutive order, as it is somewhat expensive to bend 6-in. pipe without special devices for such work.

As to the per cent of loss by condensation, this would depend somewhat upon the steam pressure carried, but we will assume that he has 100 lb., and as his pipe is 6-in., will assume that the linear length in each of the sketches is 2 ft. 6 in. With this data, by placing a calorimeter before and after the turn, he will find a loss of about 0.9 of 1 per cent in the first and third methods and nearly 1.08 per cent of loss in the second. J. L. Bradshaw.

Wanted, Data on Gravity Oiling Economy

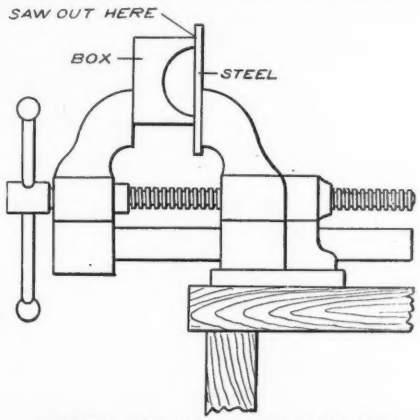
One of our engines is a 20 by 38 by 42-in. compound, running 87 r. p. m. This engine is oiled from ordinary sight-feed oil cups, which are filled by hand as required. The oil is caught and filtered for future use.

As it is not convenient nor possible to indicate the engine and ascertain its frictional load, it has been assumed to be 60 hp., or 0.1 of its rated capacity.

I am considering the installation of a gravity oiling system on this engine and shall be pleased to learn through the columns of Practical Engineer what results the readers have had in reducing the frictional load after equipping an engine with an oiling system, and if no tests have been made, give a conservative estimate of what can be saved. P. E. M.

Squaring a Journal Box

In trying to file a set of boxes a great deal of trouble is experienced to get them square unless one keeps in practice with the file. I have found that by holding the box against a square piece of steel in the vice and sawing between the box edge and the steel with a hack



METHOD OF SAWING A BOX SQUARE

saw, as the box is softer it will be cut, and the steel will keep the saw square, but don't go through on 1 side without starting on the other or matters will be worse than when starting. Leave just enough to hold, then when it is removed the job will be as good as done on a planer, needing only a little touching with the file.

D. F. Crowther.

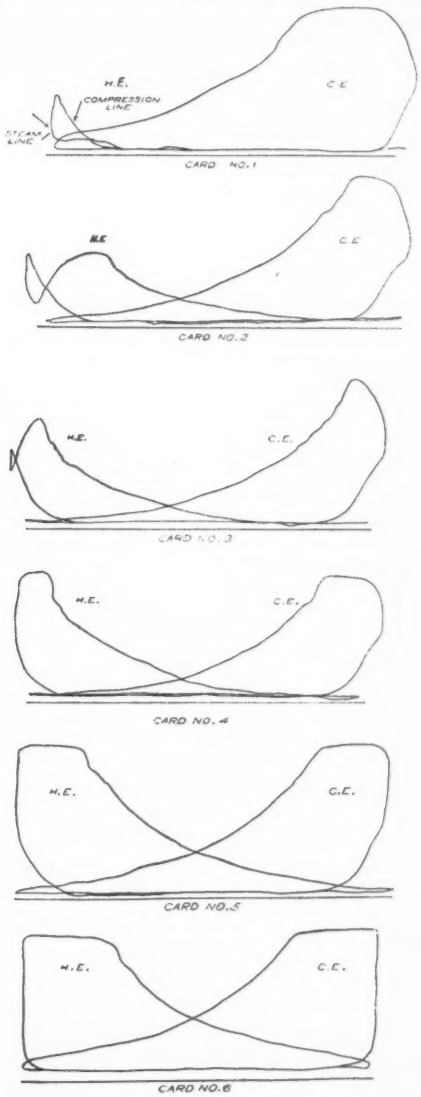
Setting the Brown Engine Valves

I was once called to assist a friend of mine who had recently taken a new job, and as he stated the engine, being an old Brown, was completely mixed up as regards the valve gear, requiring a man to stand by it and 125 lb. of steam to make it do the work, which necessitated putting in a motor to help it out. There were numerous unnecessary marks on the valve gear, so I first applied the indicator and the result was card No. 1, which showed the conditions. At once I proceeded to verify my steam laps and get the length of my valve stems by a method I found worked well.

To get the length of the steam valve stem in the old way, it is necessary to take off the valve chest and valve and measure from the top of the guide block to the bottom edge of the bottom port; the valve stem is the length from the bottom mark on the stirrup block to the bottom edge of the valve; if these correspond, the valve steam is the right length. There is a mark made by the builders which can be seen by taking off the guide block, and which will be found scratched on the bed of the engine. When the valve is down on the bottom of the steam chest the end of the valve stem should come just opposite this mark; if not, screw in or out, as the case requires.

Instead of this method I opened the indicator pipe on the end and noted the marks on the stirrup block. Taking a bar I raised the valve until I got a puff of steam out of the indicator pipe and noted the distance the valve stem traveled, for the engine was known to be fairly tight. I changed the valve stem until the travel corresponded to the marks on the stirrup block.

After getting my laps I proceeded to set the valves. Card No. 1 showed the head end events to be late; so I advanced my head end eccentric, getting earlier admission, as shown in cards Nos. 2 to 4, which, it will be noted,



CARDS SHOWING STAGES IN SETTING VALVE

caused the crank end to shorten up its cutoff because of the head end doing its share of the work.

Next I advanced the crank end eccentric, which gave me an earlier opening in card No. 5, crank end. Then turning to the exhaust eccentric I threw them both back to delay the time in closing, decreasing the compression as shown in card No. 6. Then I proceeded to balance up the cutoff, making the crank end 7/16 in. and setting the head end to correspond by loosening the setscrews and pushing the taper pin in or out, which will get things down fine; there are only setscrews on the crank end,—no taper pin. Card No. 6 is the result of the change, which shows fair conditions as they are today.

After blocking the governor in its highest position I adjusted the tripper by turning the top of the whole cut-off shaft away from the engine, and revolving the hand wheel until the valves would not pick up in case the main belt breaks or the engine loses its load in any way.

This engine has been working with a large amount of lap on the steam valves, consequently most of the eccentric throw was taken up before the valves were open, decreasing the range of cutoff or the time the valve was kept open. It is only one of the many cases showing how the indicator is the most valuable asset an engineer can possess; we learn from the first sight of a card how to proceed, which otherwise would be mostly guesswork.

A. C. Waldron.

Packing Tools

Often one finds an engineer who doesn't have proper tools for removing the old packing from valves and glands nor does he know how to make them, which is simple and the cost small. Figure 1 shows the simple hook used on valve stems and small glands where the packing is soft; it is made by drawing the ends of a tool-steel rod to long points and turning the upper end slightly, while the other is turned a little more than 90 deg., then temper to a blue so that the ends will bend

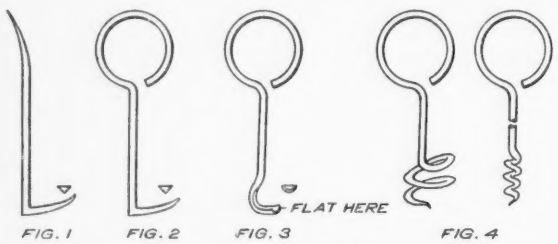


FIG. 1. HOOK USED ON VALVE STEM PACKING
FIG. 2. HOOK FOR DEEP GLANDS
FIG. 3. GLAND SPOON
FIG. 4. SCREW FOR REMOVING PACKING

before breaking. Figure 2 shows a hook for the same use where the glands are deeper.

Figure 3 illustrates a gland spoon to clear the bottom of the gland and is made wide and flat on the turn. Figure 4 is a screw which will remove anything that it will go into and is made as the hook shown in Fig. 2, making the first bend about 2 in. from the end for a ¼-in. screw, then turn that at right angles again, keeping the starting turn square on the anvil or vice, roll it around as the turns are made to keep them square, and finally temper the same as the others.

Where the gland is small and deep or the packing very hard, a small wood screw welded or brazed to a rod as shown in Fig. 5 will make matters easy and where the gland is large and packing hard a large screw put in a piece of pipe having 1 or 2 in. end play and tight other ways will come in handy in starting the packing; this is shown in Fig. 6.

For removing flange packing a fine wood-splitting saw will give good results where the space is small, as a coarse saw would make too many chips to cause trouble if they went into the pipe. Where clamps are used or the space is large, a grass sickle with the back ground off will be handy and a putty knife welded to a small pipe for a scraper is convenient.

D. F. Crowther.

A Home-Made Flywheel Remover

Having had a great deal of trouble in removing the flywheels of gasoline engines where the key heads had

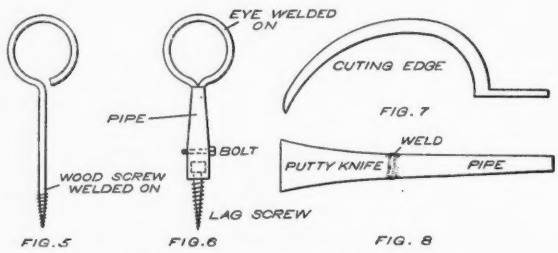


FIG. 5. WOOD SCREW ON END OF ROD
FIG. 6. LARGE SCREW FOR REMOVING TIGHT PACKING
FIG. 7. HOOK MADE FROM GRASS SCYTHE
FIG. 8. PUTTY KNIFE FOR SCRAPER

been broken off, leaving the key flush with the hub, the home-made remover here described proved quite successful. The only materials required are a carpenter's bench screw and a few pieces of board along with 2 bolts equipped with nuts and washers. A saw, brace and 2 bits are the only tools needed.

The piece A, which has the bench screw socket set into it, must be a little longer than the flywheel diameter so that the bolt holes can be set far enough apart to allow the bolts to clear the edge of the wheel. A piece of 3 by 4 answers very well for ordinary work, especially if it is hard wood. A wheel that is badly rusted on may require more of a pull than a piece of timber of this size will stand, as the hole for the bench screw reduces the strength considerably.

The bench screw socket must be placed in the center of the piece of timber so that the end of the screw can be placed against the engine shaft. The bearing prevents the placing of a single timber across the back of wheel so the 4 pieces, B, C, D and E are required

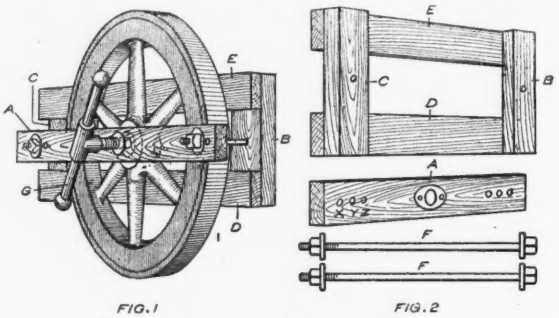


FIG. 1. METHOD OF REMOVING A FLYWHEEL
FIG. 2. PARTS OF FLYWHEEL REMOVER

to take up the strain. D and E can be made of 1 by 4 in. boards the same length as A, while B and C will answer very well if made of 2 by 4 in. material.

If the end of the bench screw is a little rough it should be filed off round so that it will center on the shaft of the engine. The nuts on the bolts should be screwed down until the frame is tight on the wheel, then the screw can be forced in until the wheel is drawn off.

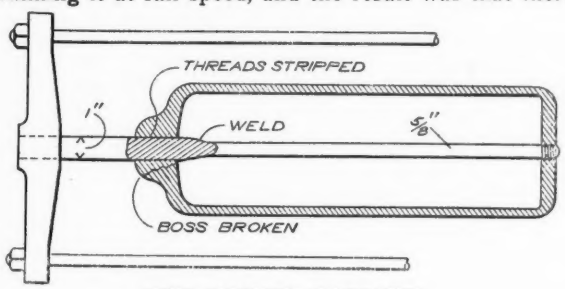
Bolts with long threads will make the apparatus adjustable for wheels of different thickness, but, if these are not obtainable, blocks of wood pierced with bolt holes can be used as washers to build up to the threaded portion.

Several holes in A, Fig. 2, illustrated at X, Y and Z, will allow for adjustment to wheels of different diameters.

J. H. C.

Pump Plunger Repair

A pump man in one of the mines here attempted to start a Worthington duplex, outside, end packed pump without first priming it, and had tried to prime it by running it at full speed, and the result was that there



PUMP PLUNGER AS REPAIRED

was a pump to repair at once, and I was sent to do the job.

I found that the plunger connecting piece had stripped the threads completely out of the plunger and the connecting piece was 7/8 in. in diameter. I removed it from the crosshead, rebored the hole and tapped it for 1 in., then I rebored and tapped the hole in the plunger end for 1 in. I found the boss shattered so badly that I had to weld a 5/8-in. rod on the connecting piece, thread the end of it for 5/8 in., and then drilled a hole in the other end of plunger for the 5/8-in. rod to screw into. It made a very quick as well as serviceable job.

Bolting on a Boiler Bracket

Two years ago, while in charge of Jackson county's traction engine, I was confronted with the proposition

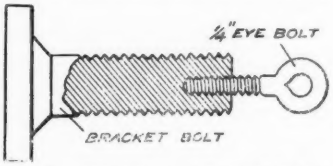


FIG. 1. BRACKET AND EYE BOLT

of keeping the intermediate gear bracket fastened to the boiler. When I was placed in charge of this engine this bracket had been replaced on the engine 4 or 5 separate times and the holes in the shell of the boiler had been cut and rethreaded until it was not safe to increase the size further; so I had the authorities get a new bracket. I turned out some bolts of Swedish iron with a taper head and flat seat, as shown in Fig. 1, with a 0.25-in. hole threaded in the end and then made a 0.25-in. eyebolt with a jam nut to run in the end of the bolt, so I could fish them through the hand hole plate in the head of the boiler.

Everything being prepared, the placing of these bolts

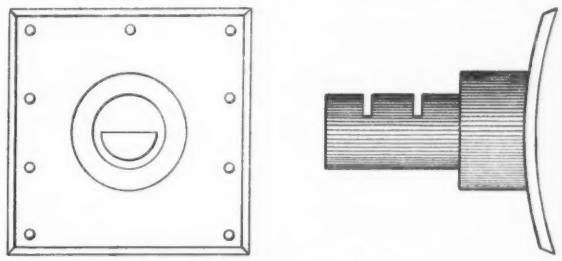


FIG. 2. INTERMEDIATE GEAR BRACKET

was the next thing. I took some No. 14 galvanized wire and ran it through the holes in the boiler back to the handhole in head and attached it to the eye bolt, which was screwed into the threaded end of the boiler bolt. Having first made and fitted lead washers on the face of the boiler bolt head at the bottom of the taper, it was then just a matter of fishing the bolts through, placing the bracket in position, pulling upon the nuts and tightening as the boiler warmed up until the lead rings were well seated, when the jam nuts were put on.

This job was declared to be impossible by 2 or 3 first class machinists, who said that a steam tight joint

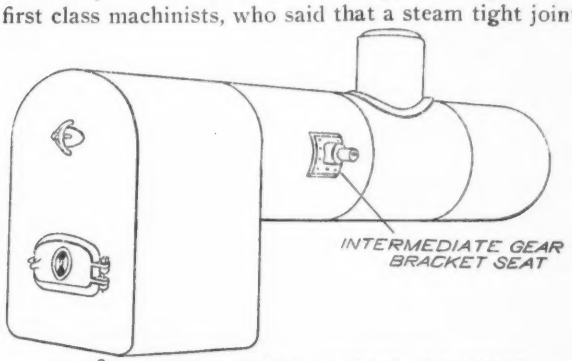


FIG. 3. BOILER SHOWING LOCATION OF BRACKET

could not be made on this job; but the engine has been in operation for 2 yr. and the engineer tells me that it has never leaked or given any trouble in this time.

W. H. Pendergrass.

"PRESENT WASTES IN LUMBER PRODUCTION are enormous. Take the case of yellow pine, which now heads the list in the volume of annual cut. In 1907 it is estimated that only ½ of all the yellow pine cut during the season was used, and that the other half, amounting to 8,000,000 cords, was wasted. Such waste is typical. Mr. R. A. Long, in his address on 'Forest Conservation' at the Conference of Governors last spring, pointed out that 20 per cent of the yellow pine was simply left in the woods—a waste which represents the timber growing on 300,000 acres."

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RAILROADS AND THE STEEL SITUATION

What has long been looked for has finally come to pass and the price of steel has become a matter of competition betwen the different makers. Just what the result of this will be on the industrial situation is not certain, but the tendency will unquestionably be towards increased buying particularly by the railroads which have delayed expansion and improvement because of high prices.

Another feature, however, which enters into the situation particularly with the railroads, is the attitude of many of the state legislatures towards the railroad companies. Whatever watering of stock may have occurred in the past has now been taken up by the good hard dollars which have been put in by the small investors. This means that unless hardship is to be worked in the country at large both upon those who patronize the railroads and those who own stock in the railroad companies, the roads must be able to earn sufficient revenue to pay dividends on their stock. It is not fair that the railroads should be hampered with hostile legislation any more than any other business, and it is only right that when any legislation is proposed in regard to the regulation of rates, or other control of financial management of railroads, a thorough investigation should be made, to see whether the measures proposed are reasonable or not, considering all the conditions under which the road is operating. Extortion does not agree with democratic principles of equity whether it be extortion from a railroad or from the pockets of the wage earner.

SAFETY VALVES

Rating of safety valves has long, in fact, always, been on an unsatisfactory basis. The only excuse for rating by the area of the disk, as has been done in the United States, the Philadelphia Lloyds, and even the latest Massachusetts rules, is that it was "easy to use." Great differences in rating have resulted, as was shown in the issues of July and September, 1908. The tests and derived rules given in this issue are a step in the right direction, but it is the opinion of many engineers that a limit should be placed on the lift allowed. High lift means small diameter and a cheaper valve for a given capacity than low lift; but it gives less certainty of action, especially in the larger sizes. Also the limiting of the diameter valve allowed to 5 in. makes the use of more than 1 valve imperative for large boilers unless the capacity is increased by high lift; which is a temptation to use high lift and avoid the cost of 2 valves.

Safety, as the name of these valves implies, is the foremost requisite, hence, limitation of lift and diameter, both seems necessary. Then a rule for capacity based on experiment and taking account of both diameter and lift will put the matter on a reasonable basis, to which all governing boards can and probably will readily agree.

EDITORIAL CHAT

Boiler Draft

In a general way we have always thought that the more draft a boiler had the more coal we should burn, and that, if you wanted to carry a thick fire, you had to put on a blower or build more chimney, also that the only way you could get more power out of a given collection of boilers, grates and furnaces, was by forcing the draft so as to get more coal burned, and that, if you did this, you were likely to get poorer efficiency than when the plant was running at an easy trot rather than a hard gallop. Now comes along the United States Geological Survey, which has been busily occupied for the last two years in overturning all our pet traditions and notions, with the radical statement that "the experiments so far made seem to indicate that it is possible to double or treble the capacity of a plant without making any radical changes in the furnaces and boilers."

The full report of this series of tests, which was written by W. T. Ray and Henry Kreisinger, is not yet available, but an extract of it has come to hand and it presents some interesting propositions. A funny thing about these investigations is that instead of experimenting any more with boilers and grates and coal and oil burners and all that sort of mussy stuff, the new system is to try experiments with something that has no relation whatever of itself to the use of a boiler. This is done, of course, because when using a lot of coal, which may or may not be always the same quality, and the same amount of moisture, and with all other things exactly the same, and on grates and furnaces which certainly will never be the same, the results obtained may prove something or nothing, according to how much care has been taken and how much certainty is involved. It is like the method of finding out how much steam will be condensed in your steam pipe with and without insulation by putting through hot air heated with electric wires instead of letting steam through the pipe. It is a lot cleaner and nicer and also gives results which are worth something where the method of testing by steam for condensation generally does not.

The way these enterprising and energetic young men went at this problem was to take a lot of hot shot—not figuratively but actual lead shot—and make up 2 beds. What they were after was to get some clear, definite notion of how much draft it took to pull a certain amount of air through a fuel bed and how the thing worked anyway under varying conditions, instead of just guessing at it by ordinary methods where the gas is so hot you cannot get near enough to take any observations and the amount of air space you get through the fuel bed is something no one on earth can by any possibility find out. With the shot, of course, a given depth will give about the same amount of air space, for the shot are all the same size and the same shape and will bed together in the same way every time.

In experimenting, one bed of this shot was used to represent the boiler or heat absorber and was always kept in the same condition. The other bed, which was supposed to represent the fuel, was varied as to size of shot and depth of bed used, and measured weights of air were passed through these 2 beds in series. The observations were, of course, as are all observations made by the Geological Survey, carefully taken and after the results were obtained they were plotted out and studied to find out exactly what the results meant and what facts and laws were shown.

Now, the point is that in order to burn a fuel bed of 8 in. thick you must get twice as much air through it as you do through a bed 4 in. thick, because there is twice as much carbon, and oxygen must be furnished to burn it. This means that you have to use a large drop through the fuel bed because it is thick and you have to use a high velocity of air through the fuel bed because you want a lot of air. But this investigation, combined with the one previously made on the matter of the amount of heat that a boiler can take up, seems to indicate that the boiler itself can take in, digest and turn over to the steam pipe 2 or 3 times as much heat as we have been giving it credit for and that the thing that holds us up in boiler capacity is the furnace and fuel bed and not the boiler itself.

The whole talk of the wise people who are doing new things in boiler plants is towards this pushing of the boiler heating surface up to its maximum, which is probably 3 or 4 times what it has been doing in the past. A notable instance of this is in the Rapid Transit Co.'s plant in New York, where they are using a stoker under each end of several Babcock & Wilcox boilers, nearly doubling the amount of steam produced and losing only 3 per cent in the total efficiency of the outfit. This arrangement of 2 stokers simply gives a burning of twice the fuel without altering the draft. Now, by using the same grate, putting on twice as much coal and putting on blower draft enough to send the air through needed to burn coal, we may be able to get the same result. We shall have to have, of course, fans designed to furnish the air needed at a good fan efficiency, and a grate designed to stand the punishment which will come from that kind of a fire, but the whole present indication is that boilers in the past which have been masquerading as 50 and 100-hp. boilers will in the future have to hustle and do the real work that is in them of 150 to 300 hp. It takes money, of course, to force the air through these fuel beds and boilers at high speed, and it may be that the wiser plan will in the end be found in using twice as much grate surface and keeping the fuel about the same thickness, but either way you get at it, it means the same thing for the boiler. The heating surface has to stop loafing and really do what it was put there to do—take in heat units as fast as the laws of nature will let it.

ELECTRICAL MACHINERY AND APPARATUS

INSTALLING AND TESTING TRANSFORMERS

CENTRAL station engineers are frequently called upon to install and test their line transformers, and are sometimes at a loss to know just how to proceed with the equipment which is at hand. The engineer may have a misgiving that the shipment of transformers which he has just received is not up to the specifications by which he ordered, and may wish to be on the safe side before making accusations.

Transformers used for lighting purposes are usually packed in sawdust for shipment, and they should not be unpacked unless ready to be installed, or if unpacked should have the cases filled with oil so as to prevent moisture from collecting on the coils and destroying the insulation.

All transformers are furnished with a diagram of connections, which should be studied carefully before connection is made to the line, as a wrong connection will mean wrong voltage and may, perhaps, ruin the transformer. When it is necessary to change the soldered connections of a terminal the transformer should be tipped on 1 side and partially removed from its case in order that solder or acid may not fall between the coils. When it is impossible to remove the transformers, the coils should be thoroughly protected by a suitable covering, which must be removed before the transformer is put into service. A solution of rosin in alcohol is recommended as a soldering flux.

In filling the transformer with oil, the oil should be poured so as to run down the inside of the case, thus filling the transformers from the bottom and driving all the air up through the coils, in order to prevent an air pocket, which might otherwise cause a hot spot and a burnout of the transformer.

The proper size fuse to be used on either the primary or secondary circuit may be found by dividing the rating of the transformer in watts by the voltage of the circuit, the result being the current in amperes.

Every effort should be made to protect the workmen from the danger of a shock, and this danger may be greatly reduced by grounding some one point on the circuit, which is permitted by the National Board of Fire Underwriters. The actual voltage which may be experienced is then limited to the normal voltage existing between the grounded point and the line, even if the primary and secondary circuits become mechanically connected either inside or outside the transformer.

When a circuit is to be grounded, the neutral or middle point should be used, if available, and transformers are usually so arranged that the middle of the secondary winding can be grounded. The ground connection should be of copper wire not smaller than No. 6, B. & S. gage, soldered to the point which is to be grounded and firmly connected to a water pipe or other suitable ground.

A transformer should not be put into service if it has been exposed to moisture without first drying it out; this is done by circulating sufficient current through its coils to maintain a temperature of about 170 deg. F. To determine the temperature, place the thermometer between the coils and well in contact with them. The cover should be left off the case when drying out a transformer so as to allow free escape of moisture; do not fill the case with oil until the transformer is dry. The proper current through the coils is maintained by supplying the high-tension or primary with a voltage about 1/20 the rated capacity, while the secondary or low-tension side is short circuited, the current being regulated by an adjustable rheostat which is placed in the primary circuit.

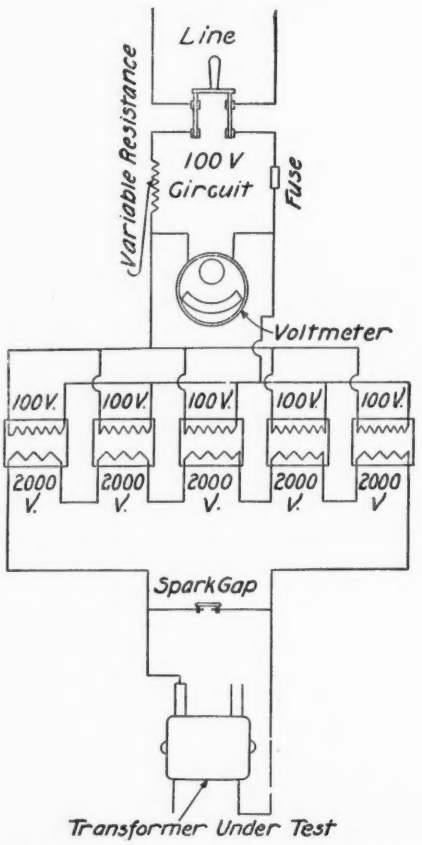


FIG. 1. CONNECTIONS FOR INSULATION TEST

If the resulting current gives a higher temperature than 176 deg. F., reduce the voltage by cutting in, and if a lower temperature, raise the voltage by cutting out

resistance. While the drying-out process is going on, the transformer should be inspected frequently and adjusted to suit any change in the condition of the line. The drying-out process will vary in time required with the amount of moisture absorbed by the transformer and will usually be about 24 hr., but in cases where the transformer has been very wet, the drying should continue longer.

Insulation

The insulation of transformers with the primary voltage of 2,000 when heated should withstand a difference of potential of 10,000 volts alternating current, between the primary and secondary coils, and between the primary coils and the core, and 5,000 volts between secondary and core, also a no-load run at triple voltage for 30 min. The triple potential test should be made on a circuit of 125 cycles or more, as this test made on low frequency circuits is harmful to the transformer due to the heavy exciting current. It is desirable when making the insulation test between the primary and secondary and between the primary and core, to connect all leads of each winding together, and also to ground the secondary winding to the core.

A single transformer wound for 10,000 volts should be used in this test, if possible, but where it is not to be had tests can be made by using 5 transformers of 2,000 volts. The secondaries of these transformers should be connected in parallel to a 100-volt circuit and the primaries in series with the transformer to be tested, as shown in Fig. 1. Care should be taken to bring the voltage up gradually, upon the 100-volt side of the transformers, as there is a potential difference on the end transformer of 10,000 volts between primary and secondary windings. This method is not advisable and should be used only when a testing transformer cannot be obtained.

The sparking distance for 10,000 volts in air is 0.5 in., and this adjustment should be made to protect the transformer from an over voltage.

This test, together with those which follow, are recommended by the Fort Wayne Electric Works and will be found efficient and practical.

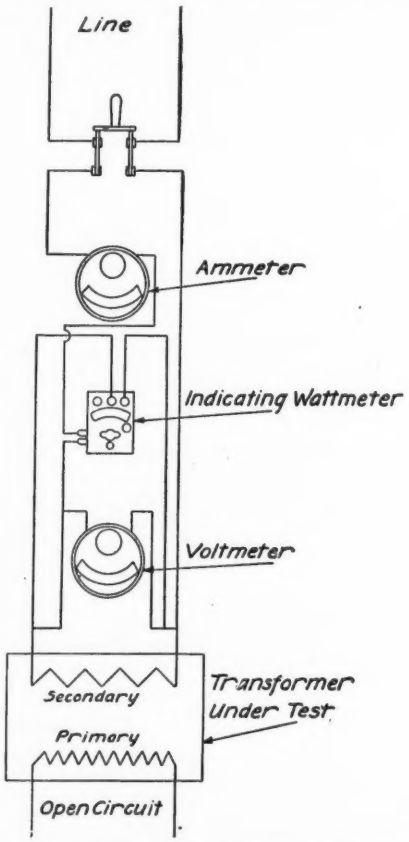


FIG. 2. CONNECTIONS FOR CORE LOSS TEST

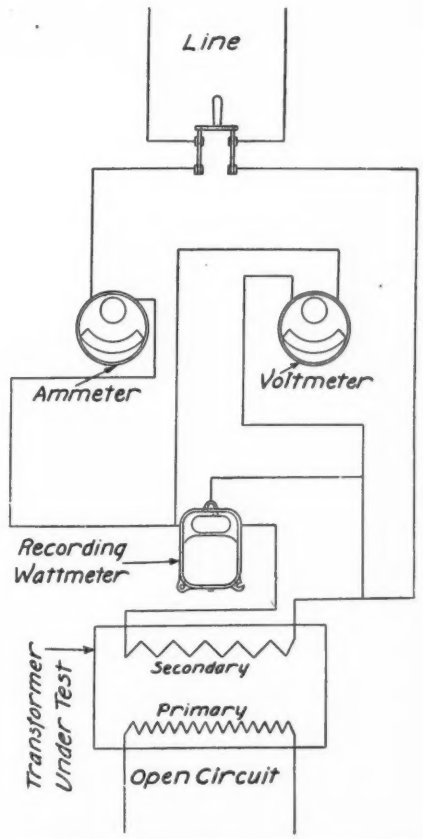


FIG. 3. CORE LOSS TEST USING RECORDING WATTMETER

Tests for Losses

Losses which take place in a transformer are due to hysteresis and eddy currents in the iron and resistance of the copper circuits.

The core loss is taken at a voltage of proper frequency impressed across the low-voltage terminals of the transformer under test with instruments, and other connections made as shown in Fig. 2. The wattmeter indicates the core loss and the ammeter gives the exciting current.

If no indicating wattmeter is available for the test, a recording wattmeter may be used by connecting as shown in Fig. 3. This wattmeter should be of the same voltage

as the transformer and of sufficient capacity to carry current as indicated by the ammeter. A 5-ampere meter will usually be the best suited for transformers up to and including 50 kw. capacity.

When the resistances of the primary and secondary coils are known the copper loss at any load may be calculated. The fall of potential method is the one most commonly used for finding the resistance of a coil. The connections are made as shown in Fig. 4, using direct-current instruments and either a storage battery of sufficient capacity or a direct-current generator. In this method the current and voltage are read and the resistance

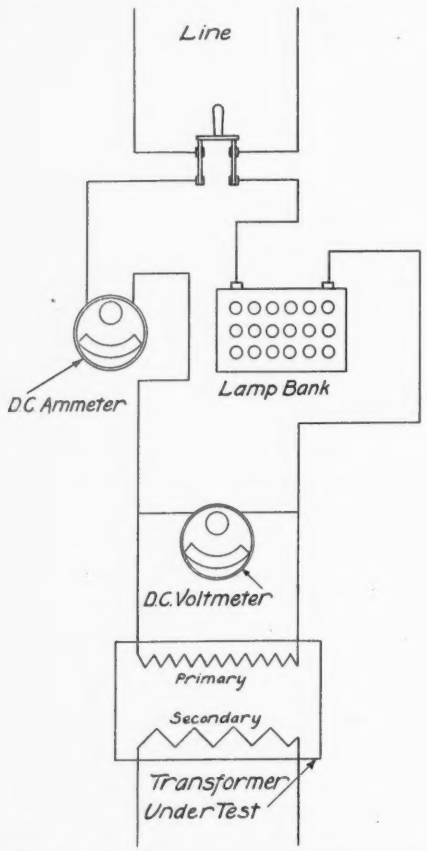


FIG. 4. DIAGRAM FOR RESISTANCE TEST

calculated being equal to the voltage divided by the current.

The total copper loss of a transformer is the sum of the losses in the circuits, the loss of either circuit being found by multiplying the square of the current in it by its resistance, the result being in watts.

The copper loss found by the wattmeter method includes eddy currents due to the cutting of the windings by the leakage flux; therefore, the copper loss by wattmeter will be slightly higher than that calculated from results found by the fall-of-potential method in a well-designed transformer.

If this loss be added to the total loss, the efficiency and total losses may be determined for each load. The connections for this test are shown in Fig. 5.

Care should be taken in short-circuiting the secondary to have as good contact as possible and connecting cables as short as possible.

The impedance of the alternating-current circuit corresponds to the resistance of the direct-current circuit and is usually expressed in impedance volts. The impedance voltage is the pressure required to force full load through either winding with the other short-circuited. Impedance volts may be measured by voltmeters, connected as shown in Fig. 5, and should be measured with full load currents flowing in both primary and secondary.

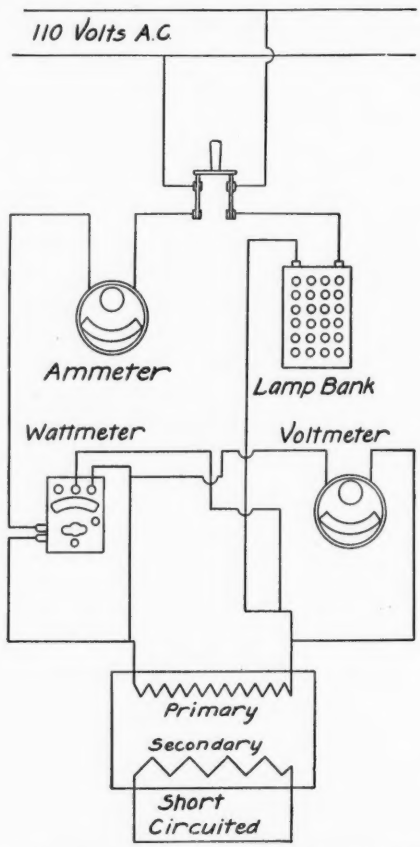


FIG. 5. CONNECTIONS TO TEST FOR IMPEDANCE WATTS AND VOLTS

The impedance voltage varies from 2 to 6 per cent of the rated primary voltage of the transformer under test. Where there is no variable resistance to be had, as shown in Fig. 5, a special method of obtaining the per cent of impedance is as follows: Short-circuit the secondary of the transformer through an ammeter, which should be of sufficient capacity to take care of at least 200 per cent of the secondary full load current, and to the primary winding apply a pressure of 110 volts alternating current; both windings should be connected for their highest voltage in the above test. The per cent impedance will then be the pressure applied to the primary winding divided by the rated primary voltage times the percent of load as shown by the ammeter, the result being the per cent impedance.

SAFETY VALVE SIZES

BEFORE the American Society of Mechanical Engineers at a meeting recently held, the question of safety valve sizes and capacities, which has been discussed at some length by our readers, was taken up and quite thoroughly threshed out by a number of engineers eminently qualified to handle the subject. The discussion was opened by 3 papers, the first of these by Frederick M. Whyte, of the New York Central Lines, the second by L. D. Lovekin, of the New York Shipbuilding Co., the third by Philip G. Darling, of Manning, Maxwell & Moore.

Frederick M. Whyte

Mr. Whyte, in his paper, spoke of the simmering or chattering effect of valves and the wide open action; the simmering valve, which is used for locomotives, opens slightly for 2 or 3 lb. above the maximum and then comes wide open for a greater rise in pressure, reversing this when closing; and another method of taking care of the over-zealous fireman who insists on making too much steam is the pilot safety valve which opens at 2 or 3 lb. pressure below the main valve. This action is chiefly useful for locomotive work. When the simmering valve is used it is necessary to make the seat of some material which will not cut out under the wire drawing action of the steam.

In locomotive practice it is unnecessary to have a valve which will take care of the full capacity of the boiler for the boiler is at full capacity only when the cylinders are working and the steam is exhausting through the stack to increase the draft.

L. D. Lovekin

Mr. Lovekin, in the paper which he presented, gave the derivation of the rule at present in use for determination of areas of safety valves by the Board of Supervising Inspectors of the United States Steamboat Inspection Service. This rule is based on Napier's rule for the flow of steam through an orifice, which is that the weight discharged in pounds per hour is equal to the pressure in pounds absolute, or the gage pressure plus 15, multiplied by the area of the orifice in square inches and by 3600 and divided by 70.

In the older practice of the supervising board, no account was taken of the amount of steam being generated, the assumption being made that the possible amount of generation should all be taken care of. A rule which attempts to take care of the real flow through the valve must have some factor for the lift, and this was assumed by Mr. Lovekin at 1/32 of the diameter. The circumference of the valve would be 3.1416 times the diameter, and the height of the lift would be $\frac{D}{32}$ or the area of the orifice through which steam would flow from the valve would be $D^2 \times 3.1416 \div 32$. If we use this in the expression for pounds of steam discharged per hour, assuming also that the flow will be ¾ of the theoretical amount, it gives, the pounds discharged per hour equals the absolute pressure times the square of the diameter in inches, times 3.78.

If we change this to area instead of diameter, we get that the area equals 0.7854 times the diameter squared, and the weight discharged per hour is then equal to 4.821 times the absolute pressure times the area of the valve disk in square inches. If we divide both sides of this equation by the grate surface, so as to get the pounds of water evaporated per square foot of grate surface per hour and the area of the safety valve per square foot of grate surface, the form of the expression is not changed, and solving it for the area of valve per square foot of grate surface we get that; area in square inches equals 0.2074 times the pounds of water evaporated per hour per square foot of grate surface, divided by the absolute pressure.

This is based on the assumption of a lift equal to 1/32 of the diameter of the valve, but in adopting the rule the Board of Supervising Inspectors forgot to mention this fact and left the equation without limitation, which robs it of a great part of its value.

If a valve is to have a lift equal to 1/32 of its diameter then the inlet to the valve, as stated by Mr. Lovekin, would seem to need an area only 1/11 the area of the valve disk, but experiments have shown that a free entrance from the boiler to the safety valve is absolutely necessary to prevent chattering of the valve when opening and closing. On some valves where the inlet is through the dry pipe it was found that with steam pressure inside the boiler of 200 lb. per square inch, that in the outlet to the dry pipe near the safety valve was only 180 lb., this drop in pressure being due to wire drawing through slots in the dry pipe. On the other hand, a rule which insists that the oulet from the boiler to the safety valve shall have an area equal to the full size of the valve disk is unreasonable, as no such area can be required to pass all the steam which the boiler could make.

Experiments on United States battleships have shown that the proportion there used of an area of outlet pipe equal to half the area of the safety valve disk is sufficient to prevent accumulation of excess pressure.

Philip G. Darling

Mr. Darling in his paper gave the method of testing a number of valves to indicate the amount of lift and also to determine the discharge capacity. For testing the lift, the valve was mounted on the boiler in the regular manner, the indicating and recording devices being placed above the boiler.

Tests on Lift

A small rod is tapped into the top of its spindle, which rod connects the lifting parts of the valve directly with a circular micrometer gage, the reading hand of which indicates the lift on a large dial. The rod through this gage case is solid, maintaining a direct connection to the pencil movement of the recording gage above.

This gage is a modified Edison recording gage with a multiplication in the pencil movement of about 8 to 1, and with the chart drum driven by an electric motor of different speeds to give a horizontal time element to the record.

Steam pressures are noted and read from a large test gage graduated in pounds per square inch, and an electric spark device makes it possible to spot the chart at any moment, which is done as the different pound pressures during the blowing of the valve are reached. The actual lift equivalents of the pencil heights upon the chart are carefully calibrated so that the record may be accurately measured to thousandths of an inch.

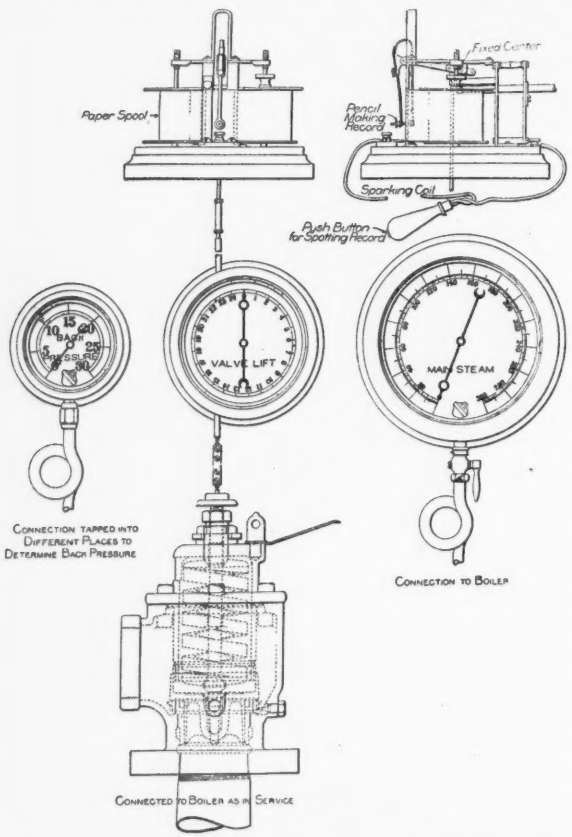


FIG. 1. APPARATUS USED TO DETERMINE LIFT OF SAFETY VALVES WHEN BLOWING

In testing, the motor driving the paper drum is started and the pressure in the boiler raised. The valve being mounted directly upon the boiler, then pops, blows down and closes under the exact conditions of service, the pencil recording on the chart the history of its action, as seen in Fig. 2.

With this apparatus, investigations and tests were started upon seven different makes of 4-in. stationary safety valves, and these tests were followed with similar ones upon nine makes of muffler locomotive valves, six of which were 3½ in., all of the valves being designed for and tested at 200 lb. The stationary valve tests were made on a 94 hp. water-tube boiler and the locomotive valve tests were made by mounting the valve directly on the top of the main steam dome of a locomotive having 50 sq. ft. of grate area and 2953 sq. ft. of heating surface.

On the 7 4-in. stationary valves the average lift at opening was 0.079 in. and at closing 0.044 in., or excluding the valve with the highest lifts, the averages were 0.07 in. at opening and 0.037 in. at closing. The valve with the lowest lifts had 0.031 in. at opening and 0.017 in. at closing, while that with the highest had 0.137 in. and 0.088 in.

Expressing the opening lifts in percentages of the highest, the lowest had 31.4 per cent., the next larger 40.8 per cent., and the next 46.6 per cent. The average of the 6 3.5-in. valves was 0.074 in. at opening and 0.043 in. at closing. The average, excluding the highest, was

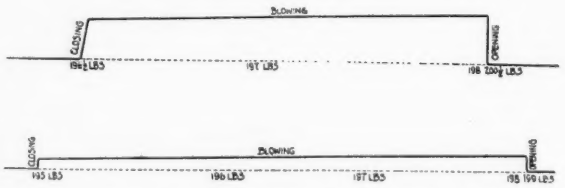


FIG. 2. DIAGRAMS FROM HIGH- AND LOW-LIFT VALVES WHEN BLOWING.

0.061 in. at opening and 0.031 in. at closing. The lowest lift valve had 0.04 in. opening and 0.023 in. closing; the highest, 0.140 in. opening and 0.102 in. closing. As percentages of the highest, the lowest lift valve was 36.4 per cent., so that under existing official safety-valve rules these valves, some of them with less than one-third the lift and capacity of others, receive the same rating and are listed as of equal relieving value.

After discussing the rule of the United States Board of Supervising Inspectors, the derivation of which was given by Mr. Lovekin, Mr. Darling stated that for valves to which this rule is applied the lifts assumed to exist are, for the 1-in. valve, 0.03 in.; for the 2-in. valve, 0.06 in.; for the 3-in. valve, 0.09 in.; for the 4-in. valve, 0.13 in.; for the 5-in. valve, 0.15 in.; for the 6-in. valve, 0.19 inch. From the experimental results given, the highest lift of the actual valve agrees quite closely with the lift assumed in the rule, but the lowest lifts have only a quarter of this amount and the next larger less than 0.5, while the average of all but the highest lift valve is only 56 per cent. of the amount assumed by the United States rule for 4-in. valves.

The Massachusetts rule for 1909, when analyzed, was shown to assume a lift of the valve of 1/33 the diameter, while the Philadelphia rule, which was quite severely criticised as having no rational foundation, was shown to assume a lift of ¼ the diameter, which would mean that a 4-in. valve would have a lift of 1 in., practically an impossible condition.

The great difficulty with all these rules is that by neglecting the lift they give the same capacity to all valves of the same nominal size, while tests show that there is a variation of 300 per cent. in valves as put out by different makers. Mr. Darling showed that in the Napier formula for the flow of steam already discussed there is

the element for a better safety valve rule than any now in use, the difficulty with this rule having been the uncertainty in regard to the coefficient of discharge or steam flow through an opening the shape of the safety valve outlet.

Tests for Capacity

To determine what this coefficient of flow should be and how it is affected by variations in valve design and adjustment, a series of tests were conducted at the Stirling Department of Babcock & Wilcox Co., Barberton, Ohio. A 373-hp. Stirling boiler, with chain grate having an area of 101 sq. ft. of grate surface was used, the boiler being fitted with a U type superheater giving 50 deg. F. superheat. Care was taken that no steam should escape from the boiler except through the valve being tested and that all water as measured went into the boiler.

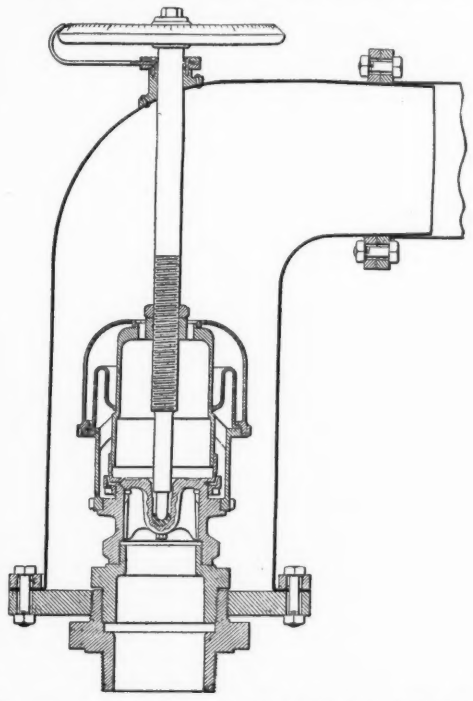


FIG. 3. ARRANGEMENT OF VALVES FOR CAPACITY TESTING

Tests were made on 3-in., 3½ and 4-in. iron stationary valves and 1½, 3 and 3½-in. locomotive valves, the latter both with and without mufflers. These valves were all previously tested and adjusted on steam without changing the position of the valve disk and ring. The springs of the valves were then removed and solid spindles threaded with a 10-pitch thread inserted through the valve casing above. On the top of these spindles wheels graduated with 100 divisions were placed, as shown in Fig. 3, giving means of measuring the valve lift to thousandths of an inch. The valve was then set definitely for each test, leaving no necessity for valve readings.

Three hours was selected as the minimum duration for a test to get satisfactory results, pressure and temperature readings being taken every 3 min. and water readings every 0.5 hr. The pressure readings were taken from 2 test gages connected about 4 in. below the valve inlet, the gages being calibrated both before and after the tests were run. In all, 29 tests were run, 15 being of 3 hr. duration, 4 of 2½ hr., 3 of 2 hr. and 7 for shorter times. From these results a constant for use in Napier's formula was found which reduced to the form that: the pounds of steam discharged per hour equal a constant times the discharge area of the valve in square inches, times the pressure in pounds per square inch. By plotting values of the constant as obtained, Mr. Darling reached the following

Conclusions

1. Increasing or altering steam pressure from 50 to 150 lb. per square inch does not affect the constant.

2. Greatly changing the shape of the valve disk outside of the seat at the huddling or throttling chamber does not affect the constant.

3. Moving the valve adjusting ring through much more than its complete range of adjustment does not materially affect the constant.

4. Addition of a muffler to the locomotive safety valve does not materially alter the constant or rate of discharge.

5. Leaving out the tests on 1½ and 3-in. locomotive valves, which were rather unsatisfactory, the different sizes of valves show a variation of only 5 per cent. in the constant when plotted for different lifts.

6. There is a slight uniform decrease of the constant as the amount of the valve lift increases.

Variations indicated in 5 and 6 were not large enough to impair materially the use of a single constant for all conditions. An average value for all 29 tests of the constant was found to be 47.5, giving that: pounds of steam discharged per hour were equal to 47.5 times the area in square inches times the pressure in pounds per square inch. This is about 92.5 per cent of the theoretical value for the constant.

Rule for Valve Diameter and Discharge

In order to make this formula of the greatest use, it should be expressed in terms of valve diameter and lift, and a further simplification can be made by expressing the pounds of steam discharged per hour in terms of boiler heating surface or grate area. Taking the valve seat as having an angle of 45 deg. and arranging the equation to give the diameter of the valve, brings the expression into the form: The diameter required for the valve in inches equals 0.0095 times the pounds evaporated per hour, divided by the lift in inches times the absolute pressure; or to determine the discharge of a given safety valve; pounds discharged per hour equals 105 times the lift in inches, times the pounds pressure absolute times diameter in inches.

If valve seats are flat instead of 45 deg. angles, the constant in the expression to find the diameter becomes 0.0067, and in the expression for pounds discharged per hour becomes 149. If the rule be changed in form so as to include the heating surface of the boiler instead of the water to be discharged per hour, diameter of the valve in inches equals a constant times the total boiler heating

surface in square feet divided by the lift in inches times absolute pressure, and for different classes of boilers this constant is found to be as follows: For cylindrical multitubular vertical and water-tube stationary boilers, 0.068, based on an average evaporation of 3.5 lb. of water per square foot heating surface, and with overload capacity of 100 per cent; for water-tube marine and Scotch marine boilers, 0.095, based upon a maximum overload evaporation of 10 lb. of water per square foot heating surface per hour. For locomotives, 0.055, which was determined experimentally, the size valves upon a locomotive being increased or decreased until one valve would just handle the maximum steam generated. Evidently if this method of design or of specification for safety valve size be adopted, it will be necessary for manufacturers to stamp on their valves the amount of lift as well as the diameter.

Discussion

In a discussion later on Mr. Darling called attention to the fact that by making a slight assumption on the side of safety the equation could be taken that: diameter in inches equals 0.01 times the pounds of steam which the boiler will generate per hour divided by the lift in inches times the absolute pressure.

High and Low Lift

Many prominent engineers interested in safety valve design and manufacture took part in the discussion of these papers. A. C. Ashton, of the Ashton Valve Co., argued that the high lift valve, which was apparently favored by the formula suggested, tends to pounding on the seat, to chattering and to the lifting of water from the boiler. He therefore advocated the use of the low-lift valve.

A. B. Carhart, of the Crosby Steam Gage & Valve Co., pointed out that the long spring valve is necessary to a high lift, that the long spring is liable to buckle and to produce chattering, and that a valve with a long motion is likely to have a spring which will teeter and wobble on the ends. He advocated a spring which at its set load would have taken from 2/3 to ¾ of its total free compression, and so designed that the rest of the compression possible before the coils struck solid should be 3 to 4 times the lift of the valve when blowing off. Like Mr. Ashton, he advocated the low-lift valve as being efficient and serviceable. He called attention at length to the advantages of the valve with annular disk and flat seat as against the valve with flat disk and 45 deg. seat, because the annular disk gives only 4/5 as much area exposed to the steam before the popping, and it gives also, after opening, a straight passage for the steam between the valve and its seat over a rounded corner; the valve requires no guides and there is no chance for it to jam.

E. A. May, of the American Radiator Co., speaking of safety valves for heating boilers, said that there is no need for such valves to be designed to take the capacity of the boiler, since the boiler is always open to the heating system mains, and usually to the entire radiating surface. He suggested that a satisfactory capacity would be obtained by taking the maximum rate of performance in such boilers as 8 lb. per square foot of heating surface for cast iron, 9 lb. evaporation of water per pound of coal, and a pressure of 15 lb.

As an interesting sidelight on the discussion, Prof. F. L. Pryor, of Stevens Institute, stated that in tests made to compare the action of steam and water in safety valves it was found that there was practically no difference in the pressure at which the valves opened. The water took 3.5 lb. higher than steam when the tests were made at 24 hours apart, 3 lb. higher when they were made one following the other, but with the valve cooled in water between them, and 2.6 lb. higher when the steam and water were used alternately by a quick change arrangement and no attempt made at cooling.

Rule for Valve Diameter

Professor E. F. Miller, of Massachusetts Institute of Technology, gave the derivation of a formula for the safety valve based on Napier's expression for the flow of steam and for a valve with a 45 deg. seat and sharp edge, assuming 9 lb. of water evaporated per pound of coal and 0.1 in. lift, he derived the expression: diameter of the valve in inches equals the grate surface in square feet times the pounds of coal burned per square foot per hour, divided by the absolute pressure times 1.206.

For locomotives, G. P. Robinson, of the New York Public Service Commission, gave a formula derived from experiment, that; diameter of the valve in inches should equal 0.05 times the heating surface in square feet, divided by the lift in inches, times the absolute pressure. This was based on the assumption that the evaporation per square foot of heating surface per hour would be 7 lb. or 50 per cent of the maximum possible, that the valve seats are beveled to 45 deg., and with the equation based upon Napier's rule for the flow of steam from an orifice. For road engines and express engines he considered that this rule gave amply large valves. For freight engines and switching engines he would use the constant 0.035 in place of 0.05.

WHEN INSTALLING STORAGE BATTERIES they must be thoroughly insulated from the floor, and there are several methods that may be employed for this purpose. Two tiers of porcelain insulators may be used, the first tier being mounted on brick piers, capped with hard pressed tile, and the first tier of insulators, which are of the triple-petticoat pattern, placed on top of this tile. On top of these insulators 2 sticks are placed, and properly covered with asphalt paint. Above these sticks are placed 3 tiles and on top of these tiles a second row of porcelain insulators, which support the battery tanks; the bottom of the tank will be some 21 in. above the floor.

The floor should be made of glazed tile or vitrified brick with joints of asphalt, as cement is attacked by the sulphuric acid which may leak over from the cells. The floor should be inclined from the cells at an angle of about 20 deg. to drain off any surface water, and should be frequently washed under the tank and the insulators cleaned.

PROPORTIONING A HOT WATER HEATING SYSTEM

SIZES OF MAINS, RADIATORS AND HEATERS

IT IS not necessary to discuss the advantages of hot water heating in this article, as it is assumed that hot water has been decided upon as the desired means. Two systems are available, one the open tank, the other the closed or pressure tank, the closed tank being run at a pressure above that of the atmosphere with 10 lb. as the proper maximum limit, and the open tank system being run at atmospheric pressure at all times so that the temperature of the water will not go above 212 deg. F. Both systems must be provided with an overflow to take care of any expansion of the water in the system, and in both systems the mains leading to and from the radiators should be pitched 1 in. for each 10 ft. of length on a horizontal run.

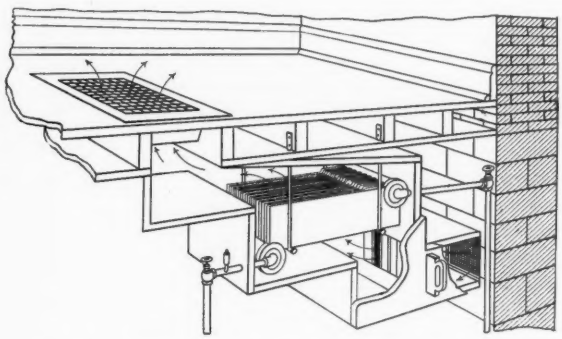


FIG. 1. ARRANGEMENT OF INDIRECT RADIATION

Mains should not be reduced in size too rapidly after branches are taken off, for the friction is greater in smaller sizes of pipe and is liable to cause trouble and insufficient heating in the radiators supplied from the far ends of the mains.

Heater Capacity

Whether round or rectangular heaters are used will depend upon the judgment of the engineer installing the plant and upon the prices that he can get, but in any case to get thoroughly satisfactory operation in the coldest weather, the heater should have a rated capacity at least 20 per cent above the total radiation which it supplies and for any indirect radiation which is used, 50 per cent should be added, while for direct-indirect radiation, 33 1/3 per cent additional must be allowed. As an example, suppose that a building is to have 500 sq. ft. of direct radiation, 100 sq. ft. of indirect and 150 sq. ft. direct-indirect. The capacity of the heater will then be found as follows:

$$100 \times 1.50 = 150$$
$$150 \times 1.33\ 1/3 = 200$$
$$500 \times 1 = 500$$

A total of 850 sq. ft.

Twenty-five per cent should be added for the surface of the mains, which gives $850 \times 1.25 = 1063$ sq. ft. and 20 per cent excess capacity provided gives $1{,}063 \times 1.20 = 1{,}275$ sq. ft. as the capacity required in the heater.

In connecting up the radiation, either the single pipe or the 2-pipe system may be used. In the single pipe system shown in Fig. 3, the hot water pipe is carried from the heater straight to the top of the building and down flow mains are taken off to carry the hot water to the radiators. Connection is made at the top of the radiator and at the bottom into the down flow main, and circulation is kept up through these 2 connections. In the double pipe system, 2 sets of mains are carried, the flow and the return, the connection from the flow main being made to one end of the radiator and to the return main from the other end. The single pipe system is used in large office buildings, as the saving in pipe is a considerable item. For dwellings and smaller buildings the double pipe system is more common. In either case, an expansion tank should be provided at least 3 ft. above the highest radiator, usually in the attic of the building, and this tank should hold 1/20 of the water contained in the entire system. It should have an overflow pipe leading from it to a sink, or sewer connection.

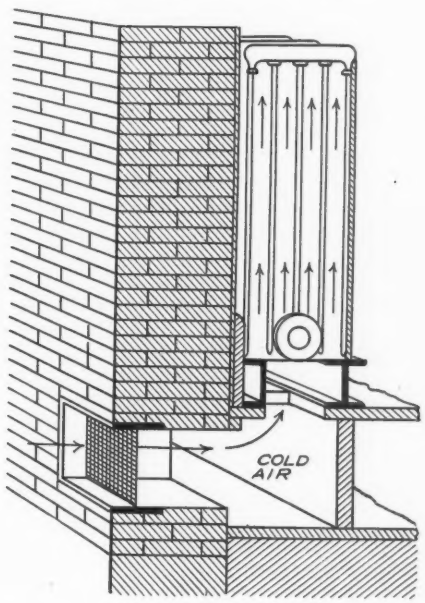


FIG. 2. DIRECT-INDIRECT RADIATOR

Radiation Surface Needed

In determining the amount of heating surface needed, the temperatures usually assumed are that a room must be heated in zero weather to 70 deg. F., the water being at a temperature of 180 deg. at the heater. This is a liberal allowance and for rooms which are not severely ex-

posed to wind or which are infrequently used, 20 per cent less radiation than is called for by these conditions may safely be adopted. It is always well to provide liberally, however, as a heater which is not forced will be more economical of fuel than one which has to be driven to keep the water at high temperature all the time.

To figure the radiation surface required, allow 1 sq. ft. of radiation for each square foot of window glass in a room; 1 sq. ft. of radiation for each 10 sq. ft. outside wall; and 1 sq. ft. of radiation for each 150 cu. ft. of space. For each degree of temperature above or below

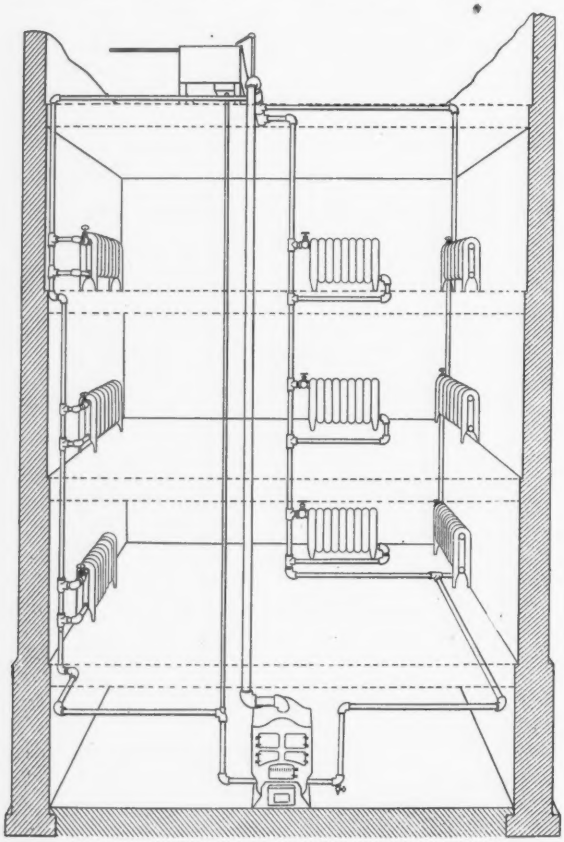


FIG. 3. CONNECTIONS AND PIPING FOR SINGLE PIPE SYSTEM

zero or above or below 70 degrees, 1.5 per cent of the radiation should be added or subtracted, as the case may be.

As an example, suppose that a room is 12 by 16 ft. and 9 ft. high, having 3 windows each 3 by 6 ft. The glass area will then be $3 \times 6 \times 3 = 54$ sq. ft., which calls for 54 sq. ft. of radiation. If the room be exposed on 2 sides, it will have an outside area of 12 by 9 and 16 by 9 $= 252$ sq. ft., which calls for 25.2 sq. ft. of radiation The cubic space in the room is 12 by 9 by $16 = 1{,}728$ cu. ft., which at 1 sq. ft. for 150 cu. ft. calls for 11.5 sq. ft. of radiation, or a total of 90.7 sq. ft. This is for direct radiation, that is, radiators placed directly in the room.

If direct-indirect radiation, that is, a radiator warming air which flows over it directly into the room, be used, an additional 33 1/3 per cent should be added; if indirect radiation, in which the radiating surface is located some distance away from the room and air is used to convey the heat, be installed, an addition of 50 per cent should be made.

Supply Pipes

The size of supply pipe allowed for radiators depends upon the amount of radiating surface supplied. For a single pipe system with direct radiators, the tapping for 50 sq. ft. should be 1 in. top and bottom; for 75 sq. ft., 1.25 in.; for 100 sq. ft., 1.5 in.; for 150 sq. ft., 2 in. For

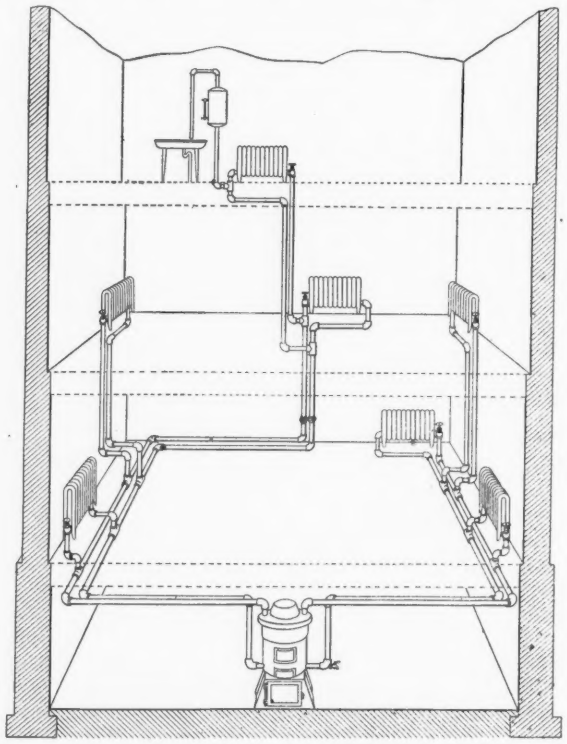


FIG. 4. 2-PIPE SYSTEM AND CONNECTIONS

intermediate values, one's judgment must, of course, govern.

With a 2-pipe system, a radiator having 25 sq. ft. should be ¾ in. pipe supply and outlet; 50 sq. ft. should have a 1 in. inlet and 0.75 in. outlet; 75 sq. ft. should have a 1.25 in. inlet and 1 in. outlet; 100 sq. ft. should have 1.5 in. inlet and 1.25 in. outlet.

TABLE. SURFACE OF CAST-IRON RADIATORS

NO. OF SECTIONS	LENGTH IN INCHES	SQ. FEET OF HEATING SURFACE			
		38 INCHES HIGH	32 INCHES HIGH	26 INCHES HIGH	20 INCHES HIGH
3	7.5	12	10	8	6
5	12.5	20	16.67	13.33	10
8	20	32	26.67	21.33	16
10	25	40	33.33	26.67	20
15	37.5	60	50	40	30
20	50	80	66.67	53.33	40

Mains

The size of main required to supply radiation is about as follows:

For	200 sq. ft.	1.5-in. pipe
	300 sq. ft.	2 " "
	400 sq. ft.	2.5 " "
	600 sq. ft.	3 " "
	800 sq. ft.	3.5 " "
	1,200 sq. ft.	4 " "
	1,500 sq. ft.	4.5 " "
	2,000 sq. ft.	5 " "
	3,000 sq. ft.	6 " "
	4,000 sq. ft.	7 " "
	5,000 sq. ft.	8 " "

When installing indirect radiation in which the heating coils are usually placed either in the basement or in a special heating compartment, the radiators are enclosed in a casing and the ceiling of this casing should be 12 in. above the radiator and the bottom of the casing 8 in. below the radiator. An inlet for cold air should have 1.5 sq. ft. cross section for each sq. ft. of indirect radiation and the warm air outlet should have 2 sq. ft. for each sq. ft. of radiation. The registers which discharge the air should be 50 per cent larger in surface than the cross section of the warm air duct.

The 2 column radiator is the one most commonly used and for cast-iron radiators the surface of a few of the sizes is as shown in the table. The 2 column radiator will have 50 per cent additional heating surface for a given number of sections and height, and the 4 column radiator 100 per cent additional.

Chimney Flues

In proportioning the chimney flues to care for a hot water heating system, dimensions needed are about as follows:

For 250 sq. ft. of radiation a round flue 8 in. inside diameter or a rectangular flue 8 by 8 in.

For 500 sq. ft. of radiation 10 in. diameter, or 8 by 12 in.

For 1,000 sq. ft. of radiation, 12-in. diameter, or 12 by 12 in.

For 1,400 to 2,000 sq. ft. of radiation, 14-in. diameter, or 12 by 16 in.

For 3,000 sq. ft. of radiation, 16-in. diameter, or 16 by 16. in.

For 3,500 to 5,000 sq. ft. of radiation 18-in. diameter, or 16 by 20 in.

APPLICATIONS OF OIL BURNING APPARATUS

Different Problems in Heating, Steam Generation, Steel Manufacture, Foundry and Blacksmith Shop Work

By C. M. Ripley

Perhaps the most unique and unexpected application of oil burning apparatus is the heating of railway coaches on the electric divisions of steam railroads. The New York Central and New York, New Haven and Hartford Railroads have both installed vertical steam boilers in the electric locomotives of their new equipment, and equipped them with Kirkwood oil burners, pressure tanks for oil and water, and utilized the compressed air system of the train for atomizing the oil.

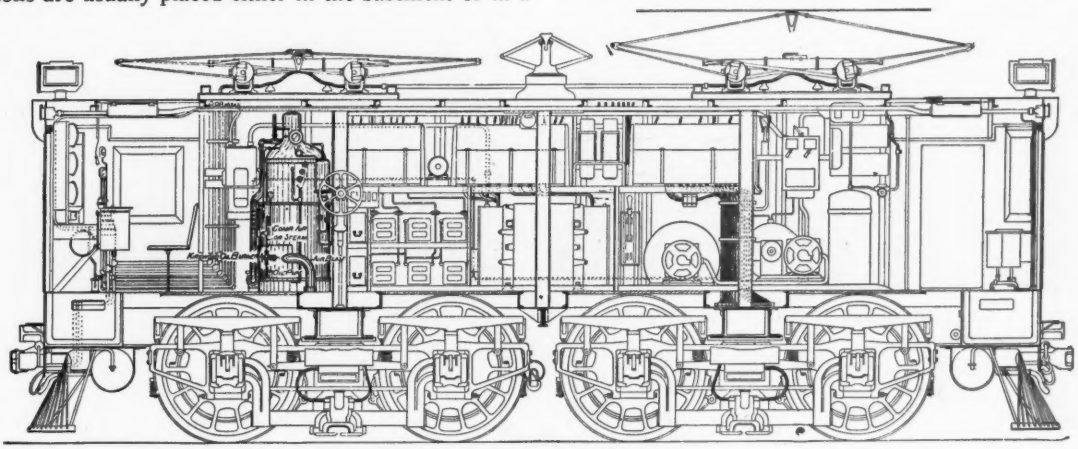


FIG. 1. OIL HEATING FOR TRAINS

Thus, as soon as the steam locomotive is detached from the passenger train, the electric motor can be coupled on and the existing piping system of the train used to heat the cars. The expense of installing elec-

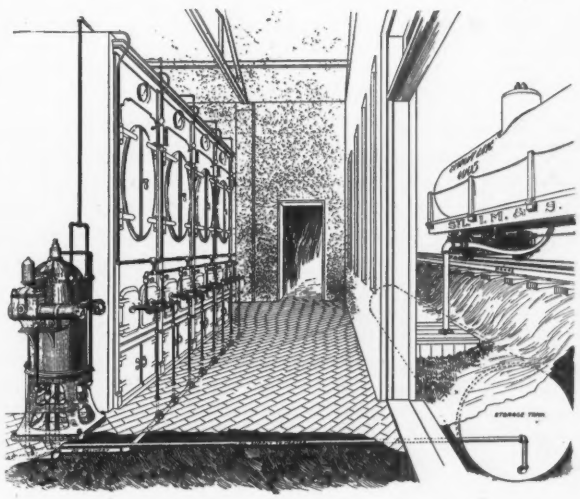


FIG. 2. SYSTEM OF OIL STORAGE FOR BOILER PLANT

tric heaters in each car, the expense of power for these heaters and the danger that would have resulted from coal stoves are all avoided in this admirable arrangement.

Steam Generation By Oil Fuel

Since the oil must be atomized, the initial starting of the fire requires either a supply of compressed air to turn into the atomizing nozzle until steam pressure can be obtained, when it is switched over to steam by a 3-way cock, or else a small boiler must be kept as an auxiliary.

This disadvantage is made up for by the fact that by starting the oil and throwing some oil-soaked waste into the firebox, the fire is instantly in full blast, which has been found to be a great time saver in the long run for plants that close down entirely. Oil with a fire test of 180 to 200 deg. F. is considered as safe as coal, which latter has been known to ignite of spontaneous combustion. If oil with a test of 250 or 300 deg. F. is stirred with a red hot poker, it will not ignite, and even a shovelfull of hot coals thrown on its surface will immediately sink and be extinguished. Crude petroleum and fuel oil are the commercial names.

Storage and Temperature of Oil

Oil is best stored when convenience and safety are both considered in an underground tank between the railroad track and the boiler room. The most successful result is obtained when the oil, fed to the burners under constant pressure, is strained and heated before fed to the furnace.

Tate, Jones & Co., Inc., of Pittsburg, Pa., have covered these points well in their various bulletins on this and other subjects, and the author recommends that those interested can get fuller information from the manufacturer, in regard to its fuel oil pumping, heating and pressure regulating systems for stationary, marine and metallurgical work.

It might be mentioned here, however, that the piping into the breeching of the boilers is frequently so arranged that a considerable rise of temperature is obtained by the time the oil reaches the nozzle, sometimes as high as 200 deg. F.

Importance of Atomization.

As in the case of any fuel, oil must be thoroughly mixed with air in order to secure complete combustion, and no smoke from the stack. If the spray of oil contains some small and some larger particles of oil, the larger particles being supplied no more air than the smaller ones, will not be burned, and the result will be a coating on the boiler tubes which is more difficult to remove than the soot deposited from a coal fire. This difficulty, however, has finally been entirely overcome by the latest designs of nozzles, which give a steady fire and no smoke.

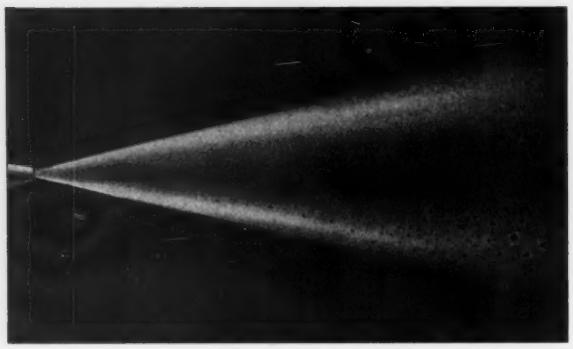


FIG. 3. IMPERFECT ATOMIZATION CAUSING SMOKY FIRE

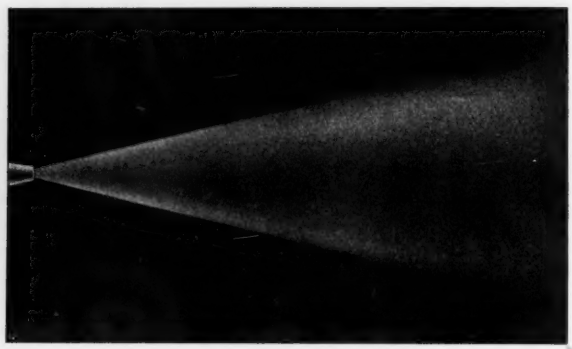


FIG. 4. PERFECT ATOMIZATION

In the Texas oil field, where oil is especially cheap, and in California, where coal is especially dear, the results of a tour of inspection will convince anybody of the fact that burners have been obtained which are most efficient and satisfactory. The old-time explosions which occurred now and then were due to the fact that the oil dripped down and later evaporated until the mixture with air became explosive. This danger has been proved a dead issue, since many of the insurance companies are giving the same rate for boilers using oil for fuel, and for those using coal.

Frequent tests of boiler pits with open flames, and many months of successful operation have convinced the most skeptical that oil burners for steam boilers are practical, safe and convenient attachments, even as auxiliary equipment. The best comparison to be made between oil burners of the present and the past is the contrast between the Welsbach gas lamps of the present that thoroughly mix the gas with the air, and the obsolete open tip that is both inefficient and filthy.

The writer has been much interested in chatting with the various manufacturers who have adopted oil as fuel, and was pleased to note the general satisfaction which followed its adoption. The quiet and unostentatious development of any line of enterprise often gains a far greater lead than is generally supposed.

THE TEMPERATURE OF THE GLOWER in the Nernst lamp is between 4000 and 4500 deg. F.; that for the filament of a Tungsten lamp is about 3300 deg.; the carbon filament of an ordinary lamp is about 3000 deg.; the temperature of the arc of an open arc is about 6250 deg.

QUESTIONS AND ANSWERS

Our readers are invited to send in their troubles and problems; also to answer questions which are asked. All letters must have name and address of writer, which will not, however, be published. If answers are wanted by mail, send stamp for reply.

Size of Wire

1. We have a lamp circuit of No. 2 wire taken from the bus bars of our switchboard, which was overloaded by the addition of lamps. The wiremen put No. 00 wire on the circuit but spliced it to the No. 2 wire, leaving about 10 ft. of this wire joined to the bus bar. Was this the correct plan?

2. We have 2 direct-current compound generators, 1 160 kw., the other 90 kw., and frequently run them in multiple. If the breaker, which is on the negative side, should open on the large machine, what trouble would there be? R. J. W.

A. 1.—In regard to the No. 2 wire left in a circuit which was replaced by a No. 00, whether it was safe to leave the No. 2 wire would depend on the lamp load. This wire could carry safely, without overheating, 180 lamps.

Probably the difficulty with the No. 2 wire in circuit was that it caused too big a drop in voltage and not that the current was more than the wire could safely carry. In that case the 10 ft. of No. 2 would not make much difference in the voltage drop. If, however, the line was carrying more than 180 lamps, the No. 2 wire should all have been taken out.

2. In regard to the 2 compound machines running in multiple, if you have, as I presume you have, an equalizer bus bar or wire, the throwing out of the circuit breaker in the big machine will probably cause simply the throwing of the breaker on the small machine and no further trouble. Of course, if the big machine went out the small machine would not be able to carry the load and its breaker should be set to relieve it instantly.

Dashpots Fail to Operate

Kindly advise me why the dashpots of our simple noncondensing Corliss engine fail to operate the steam valves when the engine is extremely lightly loaded. The valves work as if they were very dry. A small load thrown on the engine at this time will correct the trouble at once. G. C. B.

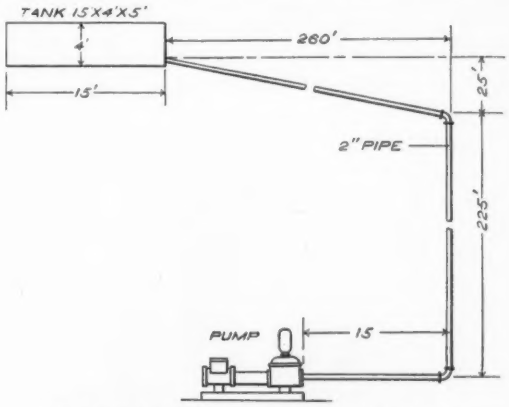
A.—I think the trouble with your dashpots is that on very light loads the lift is not high enough to give any suction. The pull-back of the dashpot is due to the creation of a partial vacuum underneath, and the amount of this pull-back is regulated by the adjusting screw on the air inlet usually underneath the dashpot. The height of lift of the dashpot plunger depends on the length of the cutoff, and at very light loads, when the cutoff is very short, the lift will be small and there will not be enough suction created under the dashpot plunger to pull it down again.

The remedy is, if your engine runs at very light load much of the time, to close down on the dashpot air inlet. If this does not overcome your difficulty, you had better write to the makers of the engine as to what you should do, because the dashpots on different engines vary so much in construction that any change other than regulation of the adjustment is not safe without the advice of the makers, who know just what can safely be done and what cannot.

Pressure of Water Column

What is the pressure a square inch at the pump with the arrangement shown in the sketch when the tank is full, and what when nearly empty? F. J. B.

A.—The water pressure in pounds a square inch is equal to the head in feet multiplied by 0.4335. When



ARRANGEMENT OF PUMP DISCHARGE LINE

the tank is full with the arrangement here given the pressure at the pump is, $254 \times 0.4335 = 110$ lb. When nearly empty the pressure is, $250 \times 0.4335 = 108.2$ lb.

Generator Trouble

We have a 300 kw. and a 400 kw. 3-phase, 6,600-volt alternating current generator; these machines are operated in parallel, are separately excited by an engine-driven 250-volt exciter, and drive a motor-generator set and 2 rotary converters. The alternating-current generators lose the load frequently when there is scarcely any load on the machines and no change in the exciter voltage nor in the speed of either exciter or generator engines. I would like to know the opinion of readers regarding the cause and remedy for this state of affairs. W. H. K.

WATER SOFTENING PLANT FOR BOILER FEED WATER

AT Ottumwa, Iowa, is located the independent pork packing plant of John Morrell & Co., Ltd., which exports the majority of its prepared meats to England. In addition to the packing plant is operated a glue plant, fertilizing and hair plant, and an artificial ice plant operated by 5 ice machines with refrigerating

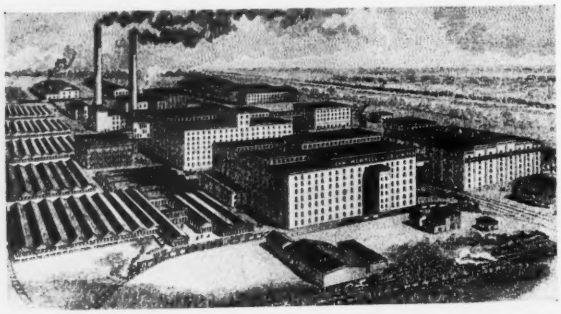


FIG. 1. BIRD'S EYE VIEW OF JOHN MORRELL & CO.'S PLANT

capacity equal to 725 T. of ice every 24 hr. The plant slaughters about 700,000 hogs a year, besides large numbers of beef and sheep. The power plant is equipped with a Curtis steam turbine and 3 Corliss engines which furnish power for practically all departments.

Steam is generated in 2 separate boiler plants containing boilers of aggregate capacity of 2500 hp., part

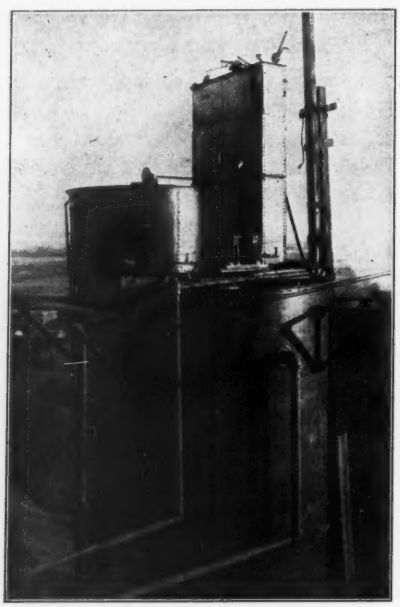


FIG. 2. WATER SOFTENING PLANT IN COURSE OF ERECTION

of the boilers operating at 110 lb. and part at 150 lb. steam pressure, all boilers being equipped with Murphy automatic stokers.

To supply the water for the needs of the plant, 4 artesian wells were sunk on the premises, varying in depth from 800 to 2000 ft. Unfortunately, after these wells were dug it was found that the water was unfit for boiler use as pumped from the wells, not only because of the scale-forming material but also because of violent foaming after the water had been used a few hours in the boilers. It became necessary, therefore, to use water from the city mains, this water being treated with boiler compounds and this method of supply was used up to June, 1908. In that month a contract was placed with the Northern Water Softener

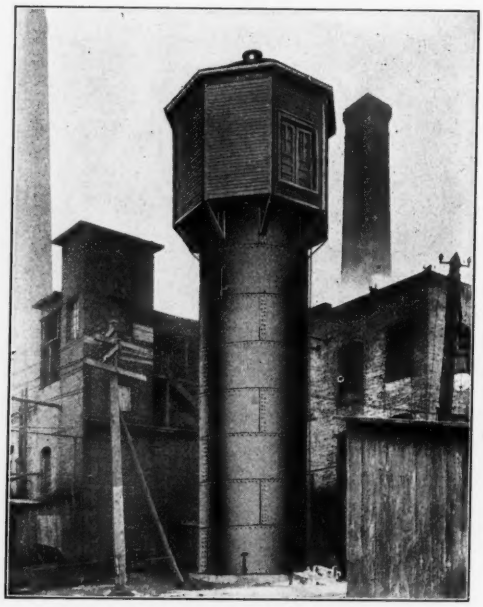


FIG. 3. NORTHERN WATER SOFTENER PLANT AS COMPLETED

Co., of Madison, Wis., for an experimental water softening plant having a capacity of treating 1000 gal. an hour, and this plant, according to the terms of the contract, was to be used on 1 boiler only for a period of 90 days.

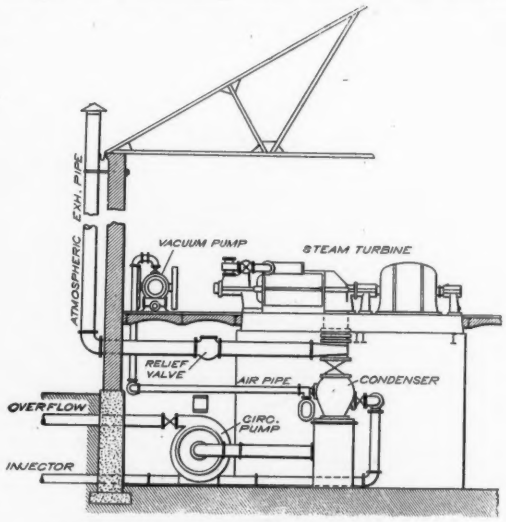
At the end of the trial, the results obtained had been so satisfactory that John Morrell & Co. decided to install permanently a softening plant which would care for the entire boiler capacity and the contract was accordingly placed with the Northern Water Softener Co. for a plant with capacity for treating 8500 gal. an hour. This plant was erected in due season, the illustration herewith showing the location of the plant, which was near the power plant, indicated on the general view by the 2 chimneys. Figure 2 shows the water softening plant under construction and Fig. 3 the completed plant as it stands at the present time. It has been in operation for some time, treating successfully all water used for steam making.

DO NOT RELY ENTIRELY upon glass water gages, but try the gage cocks frequently.

CENTRIFUGAL JET CONDENSER

A jet condenser is recommended for situations where the cooling water is fresh and suitable for boiler feed, or a fresh supply of good water can be had.

The accompanying illustration shows a Cameron centrifugal jet condenser arranged to operate in connection with a steam turbine. This arrangement is patented and was designed to overcome certain difficulties found in other designs of jet condenser sets. The condenser cone is mounted on a tank or hot well and is placed on the basement floor underneath the turbine and directly in line with the turbine exhaust opening. As the cooling water flows to the condenser



CENTRIFUGAL JET CONDENSING APPARATUS

spray nozzle under suction due to the vacuum, it is essential that the injection water opening be located not more than 30 ft. above the surface of the water supply. The incoming steam meets the water spray and, mingling with it, is condensed and falls into the hot well, from which it is pumped out by a centrifugal pump. The air and noncondensible vapors are removed by a dry vacuum pump conveniently located.

In an apparatus of this kind the cooling water must not flow into the condenser faster than the centrifugal pump can pump it out, or the condenser will flood. Nor on the other hand should the centrifugal pump pump out the condenser much faster than the cooling water enters, for if it does this, it will be pumping a mixture of water and air and is liable to accumulate air in its impeller and become air bound, or in other words, lose its suction, in which event the vacuum will be lost.

To overcome this difficulty a hot well is provided and the centrifugal pump suction pipe submerged by carrying it down inside the hot well to the bottom. The water level in the hot well under normal operating conditions is carried at about the center of the centrifugal pump. Should the quantity of cooling water be increased, the water level in the hot well will rise and result in an increased head on the centrifugal pump suction and cause the water to flow faster to the centrifugal pump. A decrease in the quantity of cooling water lowers the level and checks the quantity flowing. The centrifugal pump is therefore self-regulating, having an increased capacity as the water level in the hot well rises, and a decreased capacity as it falls. The hot well provides such storage capacity that these fluctuations in level are in no way violent. A rise and fall of 1 ft. is all that usually occurs. With 28 in. of vacuum in the condenser the water level in the hot well cannot become so low as to uncover the end of the suction pipe and allow air to get to the centrifugal pump.

The injection spray is regulated by a hand wheel on the side of the cone, and can be quickly flushed if it becomes clogged with trash. A vacuum breaker is provided to prevent the condenser from flooding in case of accidental stopping of the centrifugal pump. This style of condenser is suitable for units from 300 to 8,000 kw. and is made by the A. S. Cameron Steam Pump Works of New York, N. Y.

GANDY TRADE MARK UPHELD

It is well known throughout the power plant field, and other industries which have occasion to use belting that the Gandy Belting Co. of Baltimore, Md., manufactures a high grade of stitched cotton belting which for the purpose of identification as being of Gandy manufacture, and to distinguish it from belting made by others, has for 35 yr. been painted or dyed red, to give it a distinctive appearance and in addition has stamped upon it every 10 ft. a distinctive trade mark, consisting of a coil of belt with a bale of cotton laid across it, and the words Gandy belt and also the words The Genuine Gandy Belt. As this belt is of high quality, it has an enviable reputation which has caused it to be in great demand among all manufacturers who desire a cotton stitched belt of the highest quality. This demand has offered to unscrupulous dealers the opportunity to deceive the innocent and ignorant purchaser, by selling to him a cotton stitched belt not made by the Gandy Belting Co., of Baltimore, but dyed red in imitation of the genuine Gandy cotton stitched belting, and numerous instances of this kind of illegal passing off of inferior belting as the genuine Gandy have occurred during the past year.

In 1907 an injunction was obtained against the Waller Manufacturing Co. of Chicago, enjoining it from selling any red stitched cotton belting not made by the Gandy Belting Co. as the genuine red stitched Gandy belting; now another injunction has been issued by the United States Court in the western district of Pennsylvania against C. A. Turner, Inc., of Pennsylvania, for the same kind of illegal passing off of inferior red stitched cotton belting not made by the Gandy Belting Co. as the genuine Gandy, in response to a request for Gandy belting. The Gandy Belting Co. feels secure in its right as it has been sustained by the court, does not propose to give up the merits of

its trade mark and identifying features and will, therefore, retain its right to these features and will prosecute all dealers who attempt to pass off belts not made by the Gandy Co. as being of its manufacture. The decree against C. A. Turner, Inc., was granted on January 29th, 1909.

It is a pity that such measures must be resorted to, to prohibit the frequent fraudulent practice of those who are willing to attempt to trade upon the reputation of others. But it appears that a club is the only argument which some people are willing to recognize. The high quality of the Gandy belt is, of course, a temptation to imitators and the distinctive red color and the peculiar method of stitching are the natural features to be imitated. This method of stitching acts as a sort of trade mark, and also produces a belt that is as long-lived as it is flexible and precludes the possibility of air sacks or inequalities between the several plies of a double selvaged goods woven especially to size.

A NEW METHOD OF CYLINDER LUBRICATION

Some interesting results in the old problem of cylinder lubrication are now being achieved by the Ohio Grease Lubricant Co. of Loudonville, Ohio, with

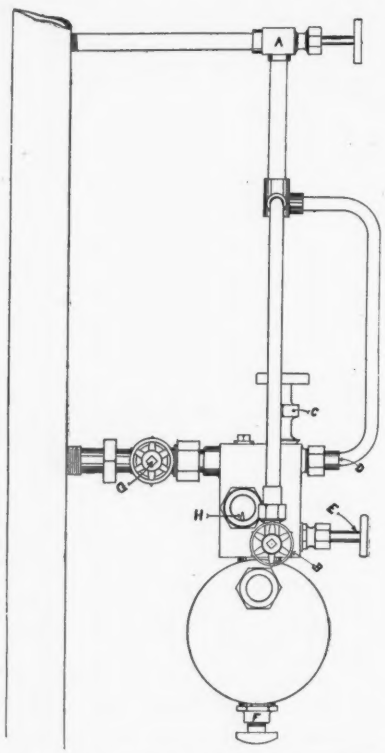


FIG. 1. PARTS OF CYLINDER LUBRICATOR

its sight feed cylinder grease lubricator. Fig. 1 shows the parts of the apparatus and their arrangement.

Steam, coming from the main pipe through the condensing valve A, passes down the condensing pipe to the lower condensing valve B. From this, as shown in Fig. 2, the condensed steam flows inside the lower chamber to the bottom, filling the chamber with water and forcing the grease up through the nozzle H, the drop from which rises and is carried by a jet of steam from the combining tube D, through the delivery valve G into the steam pipe. Grease is filled into the apparatus through the filling cap C, the water being drained out through the valve F. The valve E regulates the rate of feed.

While the ordinary cylinder lubricator feeds cold oil, the Ohio grease lubricator feeds hot grease; while the common hydrostatic lubricator performs one function, that of forcing the oil into the feed pipe by pressure induced by condensation, the Ohio lubricator performs three, namely: Keeping the grease in a melted state, forcing it to feed by direct hydrostatic pressure, and forcing it into the steam pipe and spraying or atomizing it so that the steam can carry it to all parts of the cylinder and valves. Superheating is accomplished by the combining tube D which, passing through the grease in the head portion, sets up a circulation of lubricant which very quickly brings the grease to a uniform temperature of about 130 deg. F. The hydrostatic pressure is developed by the condensing tube in the usual manner and the combining tube, D, by means of a jet forces the grease into the steam line and atomizer system.

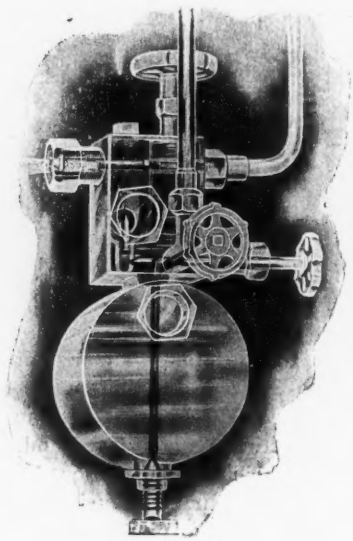


FIG. 2. SECTIONAL VIEW OF LUBRICATOR

It is claimed by the manufacturers that this method eliminates all waste and makes possible the use of a lubricant which has a higher vaporizing point and a greater viscosity and body than oil. The reports of results from actual tests would seem to prove this assertion. Tests of a year's duration at Pittsburgh, Pa., Columbus, and Canton, Ohio, and other cities have shown a saving averaging some 40 per cent over the

use of ordinary cylinder oil with an additional saving of 25 per cent in packing and reduction of wear and tear. The manufacturers state also that 1 pint of the grease is doing the work of 5 pints of oil so that the engineer is saved much bother and the work in refilling.

The grease used in this lubricator is also made by the company and is guaranteed to give a minimum saving of 25 per cent over oils, exclusive of the saving on packing, power, etc. A 2-lb. lubricator full of grease has been shown by the maker's experiments to do the work which requires 6 qt. of oil. The grease has a heavy body and the company makes assurance of its purity by a guarantee.

A most interesting feature to the engineer is that these lubricators are not sold but are leased free of

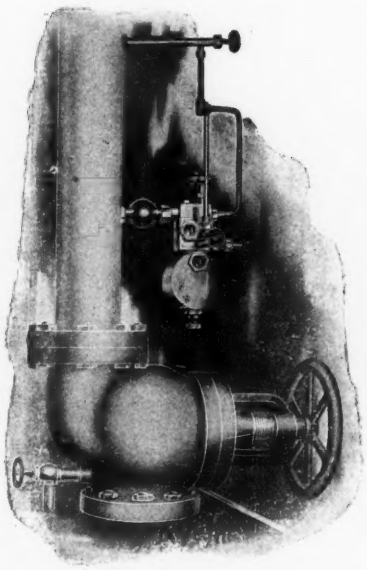


FIG. 3. OHIO GREASE LUBRICATOR CONNECTED TO STEAM PIPE

charge and in order to allow an engineer to satisfy himself of the merits of this system, the company offers a free test to any responsible engineer in his own plant. If the test is unsatisfactory there is no expense to the engineer; if the test proves satisfactory the only expense is the cost of the grease.

ECONOMY IN CLEAN BOILER TUBES

The loss in efficiency of boilers due to the formation of scale in the tubes is often so great that engineers, especially those where the feed water is bad, will be interested in any demonstration of specific economical results obtained by getting rid of the accumulated scale.

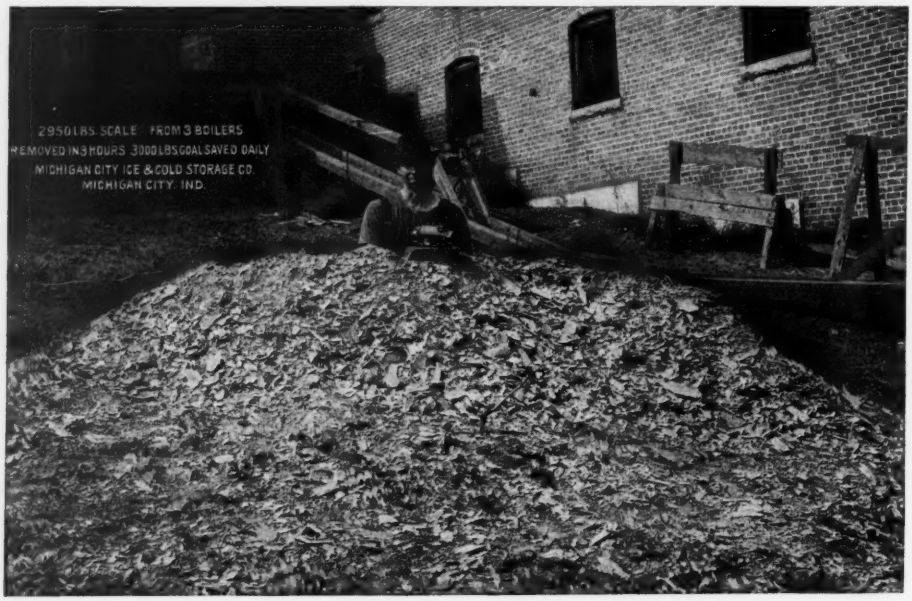
The accompanying view is from a photograph taken of the pile of scale removed from three standard tubular boilers, 72 in. by 18 ft. with 70 4-inch flues, at the plant of the Michigan City Ice & Cold Storage Co., Michigan City, Ind., recently. The Michigan company in giving its experience writes that it was decided to try a mechanical flue cleaner, not without serious misgivings, for in addition to their own doubts, the chief engineer declared that using such an instrument in these boilers would ruin the flues and cause a thousand leaks. However, when it was discovered that the engineer had been remiss in his use of boiler compound and that about 0.25 in. of scale had accumulated on the flues it was time to take heroic action and they did. The result was the huge pile of scale shown in the view, which was cut out of the flues and which was reported to weigh 2,950 lb. The removal of this scale resulted in a saving of about 3,000 lb. of coal daily, and looked-for leaks in the boiler flues did not appear. "We were aware," they stated, "that our boiler flues were badly scaled, but had no idea there was such an accumulation. The boilers are now in almost perfect condition as regards scale and we are effecting a saving of at least 25 per cent. Besides we can now use our own well water instead of city water at 6 cents a 1,000 gallons, effecting a saving to us of at least $400 a month."

The well water mentioned is obtained from 10 wells on the company's premises, each of them 6 in. in diameter and 50 ft. deep. The water is quite heavily charged with mineral substances of a kind not easily acted upon by compounds that at the same time would not tend to injure the boilers or the distilled water for ice-making. Analysis of the water showed the following solids:

INCRUSTING SOLIDS.	GRAINS PER U. S. GAL.
Calcium Carbonate	10.70
Calcium Sulphate	None
Calcium Chloride	None
Calcium Nitrate	None
Magnesium Carbonate	0.38
Magnesium Sulphate	5.16
Magnesium Chloride	0.52
Magnesium Nitrate	None
Iron and Alum. Sulphates	None
Iron and Alumina	0.29
Silica	0.76
Suspended matter	Trace
Total	17.81
Lbs. in 1,000 gallons	2.54
Free Sulphuric Acid	None

NON-INCRUSTING SOLIDS.	GRAINS PER U. S. GAL.
Sodium Sulphate	None
Sodium Chloride	1.95
Sodium Carbonate	None
Sodium Nitrate	5.69
Total	7.64
VOLATILE.	
Free Carbon Dioxide	0.64
Half-Bound Carbon Dioxide	4.88
Hydrogen Sulphide	None
Total	5.52
Hardness	16.35
Alkalinity	11.10
Acidity	None

At all events in spite of precautions the boilers had become scaled as the result of gradual deposit of these solids in the boiler feed water, and it was essential for economic operation to have the scale removed. The instrument used was the torpedo tube cleaner manufactured by the General Specialty Co., 889 Niagara street, Buffalo, N. Y., as may be seen on top of the pile of scale in the engraving. The little device is operated by air pressure and loosens the scale by vibratory action, and, as the manager of the Michigan Ice & Cold Storage Co. said, "the way that little lump of steel went buzzing through those flues and the way that scale went right and left was a caution." There is no dearth of good tools these days but there is lack of appreciation of the gain that is often possible by intelligent use of good tools. Moreover, comparatively few realize the amount of loss occasioned by incrusted flues.


29501BS SCALE FROM 3 BOILERS
REMOVED IN 3 HOURS 3000LBS COAL SAVED DAILY
MICHIGAN CITY ICE & COLD STORAGE CO.
MICHIGAN CITY, IND.

MOUND OF SCALE REMOVED FROM 3 BOILERS BY A TORPEDO FLUE CLEANER SHOWN ON TOP OF THE HEAP

SOME NEW STARRETT TOOLS

Convenient tools for the engineer and mechanic are the specialty of the L. S. Starrett Co., Athol, Mass. Among the new devices recently brought out is the engineer's taper thickness gage, shown in Fig. 1. This is especially designed for those who have occasion to test the taper of holes, the thickness of the shim needed under bearings, or the size of wire. The taper gage shows the thickness from 1/64 to 3/16 of an inch on one side, and on the reverse side is a rule 3 in. in length and reading in 8ths and 16ths.

The wire gage reads in the English standard showing the sizes from 19 to 36, and with 2 extra slots, showing ⅛ and 1/16 in. diameter. The reverse side has the holes numbered in thousandths of an inch. Besides these 2 there are 9 thicknesses of feelers 4 inches long, and having thicknesses of 0.002, 0.003, 0.004, 0.006, 0.008, 0.01, 0.012, 0.015, and 1/16 of an inch. The entire outfit is enclosed in a case which is 4.75 in. long, and of convenient size to carry in the pocket.

Another device which will be found of frequent usefulness, is the electrician's pocket screw-driver, which has a rubber handle so as to insulate it from electric current. This handle is so made as to give a perfect fit when using the tool, and has in the magazine 4 blades of different widths, which can be quickly inserted in the handle, when desired to be used. The smaller blades can be used to make holes in wood for screws as well as to drive them. The blade widths are 3/32, 5/32, ¼ and ⅜ in.

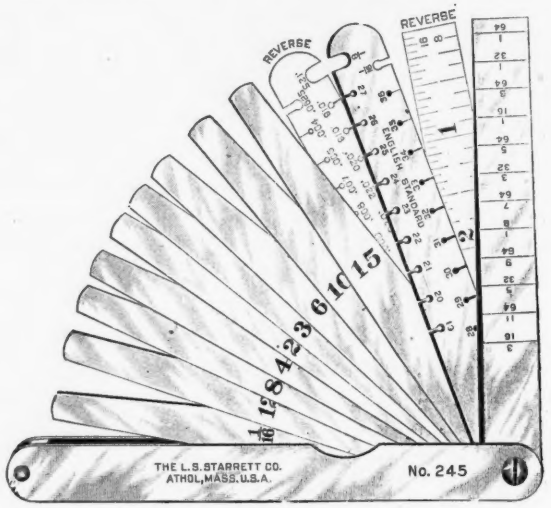


FIG. 1. TAPER THICKNESS GAGE

A third convenient tool is a fillet or radius gage,

also known as concave and convex gage, which is used for laying out special tools, etc., or for measuring the radius of fillets on wheels, as indicated in the smaller of the illustrations, Fig. 3. This gage is made in 2 sizes,

FIG. 2. ELECTRICIAN'S POCKET SCREW DRIVER

size A having 26 leaves, indicating radii by 64ths of an inch from 1/16 to ¼, and size B having 32 leaves, indicating radii by 64ths of an inch up to ½. All the leaves fold into a convenient shape for carrying in the pocket.

PROGRESSIVE GAGE MANUFACTURE

American inventive ability has not been directed very much during the past to the improvement of indicating gages, in spite of the important part they play in almost every engineering undertaking. The same form of pressure tube, the same mounting, the same method of fastening the movement, or multiplying device, to the case, has been pretty generally adhered to for years, until the makers of "Standard" gages inaugurated radical changes with a view to securing permanent accuracy in a gage which could be used under all commercial conditions at home or abroad.

The special factors to be sought in a successful gage are: 1, a design which makes the working parts independent of the case, and definite in their relation to each other; 2, the use of the best wearing, noncorrosive metals for those parts subjected to wear; 3, the selection of the most durable and best wearing form of tooth for the gears and pinions; 4, extreme care in fashioning and inspecting each little component part; 5, and the rigid calibration and testing of every instrument.

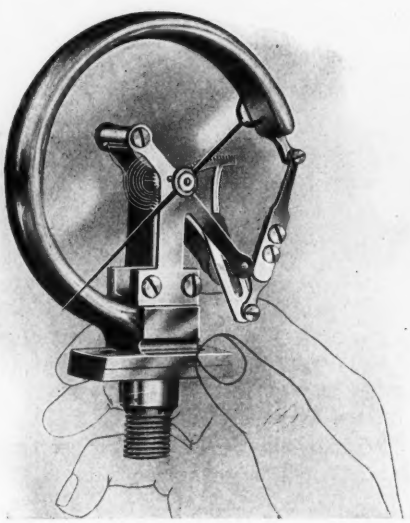
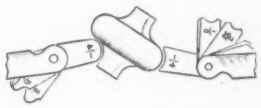


FIG. 1. PARTS OF SINGLE-SPRING STANDARD GAGE

The simplified working parts of a Standard Model A gage are illustrated by Fig. 1. They consist of a special alloy tube of elliptical cross section formed approximately into the arc of a circle. The pressure to be measured is applied at the fixed end and acting throughout the tube tends to straighten it, the closed free end moving a small amount proportional to the pressure applied. This small motion is multiplied by a lever, gear and pinion, so that the pointer will have a proportionally longer travel over the graduated dial. It is evident that the working parts cannot be affected by any motion of the case, Fig. 2, due to thermal or mechanical straining of the latter.



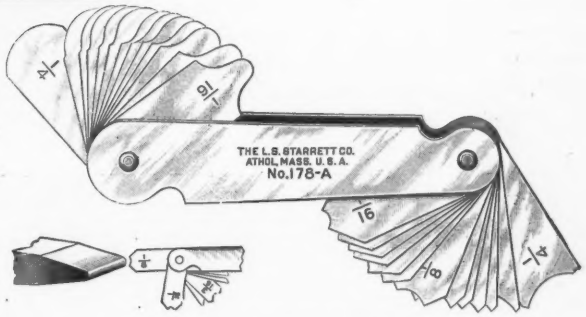


FIG. 3. FILLET OR RADIUS GAGE

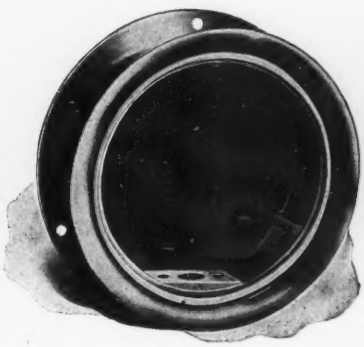


FIG. 2. GAGE CASE

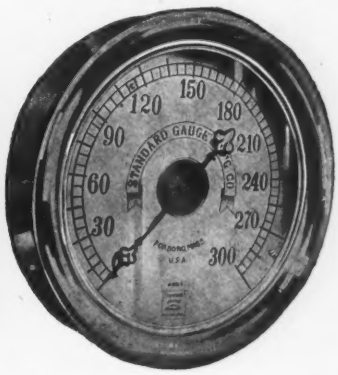


FIG. 3. COMPLETE STANDARD GAGE

The gears and pinions are cut from special composition bronze and German silver with a view to their durability. The form of tooth used is peculiar to these instruments and it is said to be exceptionally strong and little subject to back lash after wear.

An assembled instrument is illustrated by Fig. 3, the dial of which is graduated in pounds per square inch. Any system of units may be employed, however, which accord with the preference of the user. These gages are marketed by The Industrial Instrument Co. of Foxboro, Mass., which is the Sales Company for The Standard Gauge Mfg. Co., makers.

INTERNAL COMBUSTION ENGINEERS' VISIT TO GARY

MEMBERS and friends of the Internal Combustion Engineers' Association of Chicago were tendered an invitation by the Indiana Steel Co., through W. M. Hampton, superintendent of motive power, to visit its works at Gary, Ind., on March 6th. A special car over the L. S. & M. S. R. R. was secured, and 104 men interested in gas engine practice availed themselves of the opportunity to see and have explained to them the construction and operation of the Gary gas engine plant, which is the largest of its kind in the world.

This plant was fully described in the November issue of Practical Engineer, but since that article was written the electrical and blowing engine power houses have been fully equipped and a large share of the steel plant is now in operation.

A remarkable record has been made by the men who have had charge of the work of installing the apparatus in these power houses, for since May, 1908, this entire equipment has been erected and put into operation. It consists of 16 Allis-Chalmers twin tandem gas engines, direct-connected to alternating-current generators, and 17 blowing engines which are also of the twin tandem type, besides several smaller steam engines, which are used as auxiliaries and for igniting the gas engines.

At the Association meeting held March 12 Mr. Hampton favored the organization with a discussion of the power plant and told of a number of difficulties with which he has had to contend.

One of the distinct features of this plant is the quietness with which these engines run. The principal reason given for this is that they exhaust into a large tunnel, leading to the stack in which the back pressure is no more than that due to atmosphere.

An operating feature which is stated to have given some trouble is the stopping up of the cooling water jackets and other cooling parts of the engine with fish pumped from the lake, no provision having been made for screening them out.

By the thorough system for washing the blast furnace gases which are used in the engines, a gas which contains less solid matter than ordinary air is obtained. The gas used runs on the average in about the following percentages: Carbon monoxide (CO) 26.5 per cent; carbon dioxide (CO_2), 12.5; hydrogen (H), 3.3; carbohydrate (CH_4), 0.1, the remainder being nitrogen (N), 57.6 per cent. The heat value of this gas ranges from 95 to 105 B. t. u. to a cubic foot. The mixture of gas and air which has been found to give best results is about half and half.

INTERNAL COMBUSTION ENGINEERS' ASSOCIATION AT THE INDIANA STEEL CO.'S PLANT

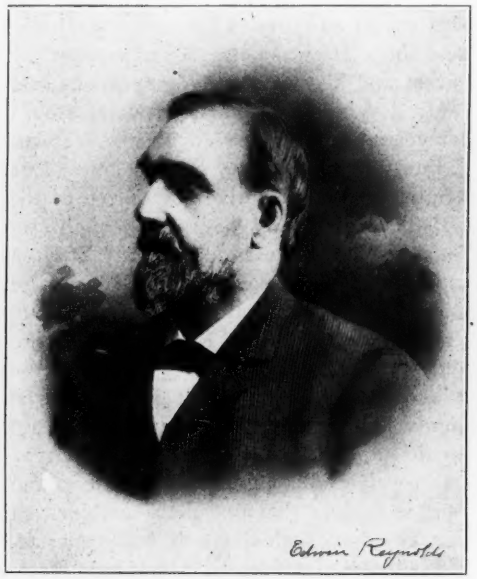
A WRITER in Brass World asks for a grease for the ground cock in a hot water faucet, and is recommended to use graphite grease, as the graphite will remain after the grease is melted.

EDWIN REYNOLDS

Edwin Reynolds, one of the great mechanical engineers of the country, and for 30 yr. practical head of the Edward P. Allis Co., now the Allis-Chalmers Co., died at his residence, 446 Ivanhoe Place, Milwaukee, Friday, Feb. 19, at 78 yr. of age.

For nearly 3 yr. Mr. Reynolds had been confined to his home; during the past year his death was expected at any time, and it was owing only to his remarkable vitality that he lived until now.

Edwin Reynolds, considered by many to have been one of the ablest mechanical engineers and designers in this country, was descended from a notable family, which was among the first to cross the ocean and set-



EDWIN REYNOLDS

tle in Rhode Island. In this family was William Reynolds, who came from Gloucestershire, England, in 1673, settling in Rhode Island. Descended from him, in direct line, was Christopher Reynolds, who was born in Frenchtown, R. I., July 11, 1790. The latter, about 1810 moved to Mansfield, Conn., where he married Clarissa Huntington, and on March 23, 1831, Edwin was born.

Having received the usual education afforded by the public schools, Edwin became an apprentice to a small machinist in his native town. With his trade fairly learned he sought and secured work in machine shops in Connecticut, Massachusetts and Ohio. Later he went to Aurora, Ind., as superintendent of the machine shops of Steadman & Co., which was largely engaged in the building of engines, saw mills and drainage pumps for Mississippi plantations. At the outbreak of the war between the states, Mr. Reynolds returned to Connecticut, and for 6 yr. he was active in his trade in that state and in Boston and New York, during which time he worked upon the machinery of Ericson's Monitor, which played such an important part in the Civil War. He then went to Providence R. I., entering the shops of the Corliss Steam Engine Co. In 1871 he was made general superintendent of the plant, remaining until 1877, when, at the earnest solicitation of the late Edward P. Allis, he resigned to engage with Edward P. Allis & Co. at Milwaukee.

Upon the death of Mr. Allis in the eighties Mr. Reynolds became, under the terms of the will, one of the trustees of his estate and, when the company was reorganized as the Edward P. Allis Co., he was made a director, vice-president and general superintendent. This position he retained until 1901, when the Allis-Chalmers Co. was organized, largely through Mr. Reynolds' efforts, and he became director and chief engineer in the new company.

Five years after the organization of the Allis-Chalmers Co., Mr. Reynolds' health failed and, while he still retained his title as consulting engineer of the Allis-Chalmers Co., his condition was such that he was unable to take any further part in the business.

While Mr. Reynolds was a man of remarkable capacity his success was, in no small degree, due to his early training. He learned his trade in the days when the apprentice lived in the house of the master and was one of his family. The lathe of the shop in which he worked consisted of an iron head and tail stock supported on wooden ways; a construction which today would hardly be considered adequate for wood working machinery, if accuracy were required. Personal skill on the part of the mechanic took the place of accuracy and refinement in the tools and appliances at his command. The resource and judgment of the young mechanic was daily taxed to contrive expedients to eke out the inadequate facilities of the shop and thus enable it to complete whatever work came to hand; and, while he acquired skill with his hands, he developed equal, or greater skill in the analysis of the problem at hand and in the art of adapting the means at his command to meet the necessities of the work on which he was engaged. It was these traits in his character which were the foundation of the remarkable success which he attained during his connection with the Edward P. Allis Co.

At the time he came to Milwaukee the shops of the company were small and poorly equipped, and the first success in his new position was the designing and building of the Reynolds girder frame Corliss engine. Viewed from the broad standpoint of engineering, this engine was not very remarkable, but to one who considers all of the circumstances, it deserves to rank as one of Mr. Reynolds' greatest achievements. It was designed to suit the capacity of the shops and men at his command and to be financed with the limited money at his disposal, and well exemplified one of his maxims, viz: "That a machine was well designed which was simple, and so designed that it could be

built with the equipment available and sold for more than it cost."

The valve gear of this engine was the first of the now well known Reynolds-Corliss gears. Its operation was remarkably successful from the start and it has since been copied, largely, by builders of Corliss engines.

In the early eighties Milwaukee was, in mechanical and engineering matters, a frontier post. It was in touch with the needs of the iron and copper regions of the north and of the steel industries to the south and east and it catered to the power requirements of the growing towns and cities of the middle west. Mr. Reynolds' skill, experience and engineering ability were taxed to meet the growing needs of the varied industries in this great territory. He was never satisfied that the solution of any problem was right simply because it had been solved that way before. It was his practice to go back to the fundamental problem and make an analysis of conditions which existed and to work out, independently of any previous effort, the solution which the necessities of the case seemed to demand.

He found the steel industry struggling with a blowing engine, which was a ponderous affair with leather valves. He brought out a direct acting metallic valve blowing engine, the first of which was installed at Joliet, proving so superior to the engines previously in use as to revolutionize the construction of blowing engines and air compressors.

Following the same mental process, he introduced in the copper industry the steam stamp, with solid anvil, in place of the spring supported anvil in universal use at that time. In reply to critics he said that he didn't "believe it good engineering to use a feather bed to break stone on." This change more than doubled the output for a given expenditure of power, completely revolutionizing practice in the crushing of ore and forcing the rebuilding of every plant in existence at that time.

He also designed and installed during this period some of the largest hoisting engines in the country, all of which are today in successful service and bear tribute to the care and thoroughness with which they were designed.

When the City of Milwaukee was confronted with the problem of pumping an enormous quantity of lake water, at low head, into the upper reaches of the Milwaukee River for flushing purposes, Mr. Reynolds proposed the now familiar screw pumping engine. At the time the proposition was bitterly denounced by practically every engineer in the country, but its extreme low cost, coupled with the faith which his fellow townsmen had in Mr. Reynolds' ability as an engineer, led to its adoption by the City of Milwaukee; an action which was amply justified by its splendid success during practically a quarter of a century's operation.

The modern high duty three cylinder pumping engine was another design original with Mr. Reynolds. At present this represents universal practice, but at the time it was introduced it was a radical departure from the type of machinery then in use.

When, in the early nineties, the infant electrical industry outgrew the capacity of high-speed engines and the makeshift system of belted connection from engine to dynamo, it found Mr. Reynolds and the Edward P. Allis Co. ready to supply Reynolds-Corliss engines of capacities suited to the growing needs of the period and the notable expansion of the company with which he was connected was, to a large extent, due to its success in the electrical field. Mr. Reynolds' largest engines were built during this period, the most notable installations being the 12,000 hp. engines of the New York Subway & Manhattan Elevated power stations.

Personally, Mr. Reynolds had, in a remarkable degree, the respect and love of his associates, both in the office and shop. He was possessed of wonderful executive ability, and his business judgment was seldom at fault. Mr. Reynolds' conspicuous worth was, during his later years, universally recognized. He was president of the American Society of Mechanical Engineers and member of the executive committee of the same society. The University of Wisconsin, his adopted state, honored him with the degree of LL. D., and his name appears on the frieze of the engineering building, an honor at that time accorded to no other living man.

With the death of Edwin Reynolds a great man has departed—great alike in his grasp of large engineering principles and technical details; great in his mastery of commercial problems; great in his foresight and faith in the development of this country; great in his relations to civic and industrial conditions and questions. It is seldom that one man combines so many qualities, any one of which would bring success.

Mr. Reynolds' services to Allis-Chalmers Co. and to Milwaukee cannot be overestimated. He was truly one of the empire builders of this country, and his large contributions to engineering are recognized the world over.

NEWS NOTES

EDWIN H. ROBERTS, president of the Standard Steam Specialty Co., who has been connected with that firm for the past 10 yr. and has built it up from small beginnings to its present large activity, was called from his work by death, in the latter part of February.

THE SPRING MEETING OF THE American Society of Mechanical Engineers will be held in Washington, D. C., May 4 to 7.

Local headquarters will be at the New Willard hotel, at which rooms may be secured by those wishing to attend by writing direct to the hotel. The University Club has extended an invitation for members of the society to make free use of its rooms and privileges during the meeting.

WALTER B. SNOW, Publicity Engineer, Boston, Mass., has been elected a member of the Corporation of the Massachusetts Institute of Technology.

J. E. LONERGAN Co. has been formed to take over the business formerly carried on at 211 Race St., Philadel-

phia, by J. E. Lonergan & Co. The new company is incorporated under the laws of Pennsylvania and has as officers: President, John E. Lonergan; vice-president, M. A. Hudson; secretary, H. S. Whitney; treasurer, W. E. Crofton. Messrs. Whitney and Hudson were for many years in New York and Chicago connected with Manning, Maxwell & Moore and the affiliated companies. Messrs. Lonergan and Crofton have been for a long time with the former company of Philadelphia.

FROM JUNE 7 TO 19 Cleveland, O., will be the scene of an industrial exposition of the articles made in the 3,500 factories, ranging from street cars and steel ships to fine wire and brads, and covering metal industries, building materials, leather goods, clothing, printed matter, wood manufactures and numberless other fields. Two large buildings will be devoted to the exhibits and will be open morning, afternoon and evening. Power machinery will be well represented.

THE ORGANIZATION OF THE ENGINEERING SOCIETY of Wisconsin was completed at the first meeting, held at the University of Wisconsin Feb. 24, 25 and 26, at which some 150 city engineers, general managers of power and traction companies, contracting engineers, superintendents of water and light plants, mechanical and civil engineers, and superintendents of highway construction were present and became charter members.

The officers elected were: President, Dean F. E. Turneaure, University of Wisconsin College of Engineering; vice-president, City Engineer McClelland Dodge of Appleton; trustees for 2 yr., B. F. Lyons, assistant general manager of the Beloit Gas and Electric Co., and E. P. Worden, mechanical engineer of the Prescott Steam Pump Co., Milwaukee; and trustees for 1 yr., E. Gonzenbach of the Sheboygan Electric Light and Power Co., and City Engineer E. R. Banks of Superior. These, as executive board, will elect the secretary later.

The new organization will hold annual meetings hereafter for the purpose of bringing together the engineers from all parts of the state interested in the solution of such problems as arise in connection with municipal plants, large construction work, bridge, forest, and water power questions, and light and power production. A wide range of subjects was included in the programme for the initial meeting of the society.

At the opening session, Feb. 24, following the address of welcome by President Charles R. Van Hise, was a presentation of the scope of the highway work of the state geological survey, by W. O. Hotchkiss, highway engineer for the survey. A. R. Hirst, also of the state highway department, spoke on the use of tar, oils, and emulsions on macadam and earth roads. The discussion on pavements was led by McClellan Dodge, city engineer of Appleton, and participated in by P. H. Connolly, city engineer of Racine; W. G. Kirchoffer, consulting engineer, Madison, and others. City Engineer C. V. Kerch of Janesville spoke on the construction of the Court street bridge in that city.

Interest in the discussion of the conservation of forests and water resources of Wisconsin, a subject presented by State Forester E. M. Griffith, waxed so keen that the paper on the water power resources of the state, by Professor L. S. Smith, who is engineer for both the state and national geological surveys, was postponed to the following evening. The conservation discussion was led by Senator T. W. Brazeau, and Senator E. E. Brown, Assemblyman J. R. Jones, and Prof. D. W. Mead also spoke on the subject.

Professor W. D. Pence, who is engineer for the Wisconsin Railroad Commission, opened the second day's programme with a description of the organization of the commission's engineering staff. The new problem of standard of gas and electric service was discussed by Professor C. F. Burgess of the department of applied electrochemistry at the university, who has done important work in enabling the state railroad commission to prescribe a standard for fuel and illuminating gas.

The electric interurban roads of Wisconsin were made the subject of an address by F. G. Simmons, superintendent of construction and maintenance of way for the Milwaukee electric railway and light company. The day circuit for small towns was discussed by Professor J. W. Shuster, and new forms of arc lamps by W. E. Wickenden, also of the electrical engineering department. Dean Turneaure took the members of the society through the engineering experimental laboratories, explaining the work that is being done there in many lines of research.

The second night was given to a discussion of water power, W. G. Kirchoffer describing the water supply of the city of Marshfield, and Professor D. W. Mead the subject of hydraulic and hydroelectric power development. Papers on the waterproofing of concrete, by F. M. McCullough, city engineer of Stoughton; municipal engineering in the Orient and in Porto Rico, by J. T. Hurd and Edwin Wray; gas producers and small power stations, by V. E. McMullen, Beloit, and C. T. Atkinson; and Madison's concrete storm sewer system, by City Engineer John F. Icke, concluded the convention programme.

EXAMINATION WILL BE HELD on April 14 and 15 at the usual examination cities to secure lists from which vacancies will be filled in the Panama Canal service. The positions open are for mechanical draftsmen, first class at $150 a month, second class at $100 a month, and topographic draftsmen at $125 a month, also tracer at $100 a month. The requirements for the position of mechanical draftsmen are knowledge of mathematics, including arithmetic and algebra, and the use of the slide rule, materials of machine construction and the ability to make machine construction drawings neatly to scale. At least 3 yr. of drafting room experience or a technical school training and one year's experience in addition to shop work on machine construction will be required. Those passing at 80 per cent or over will be rated as first-class draftsmen, those under 80 per cent as second-class draftsmen. The requirements for topographic draftsmen are: Knowledge of mathematics, geometry, trigonometry and algebra, experience in plotting of field notes, and a knowledge of drawing and lettering. Applicants must be between 20 and 45 yr. of age, in good health and physically sound. A photograph, preferably unmounted, taken within 2 yr., must be furnished with the examination papers. Anybody interested should write to the United States Civil Service Commission, Washington, D. C., for Application Form 1312, stating the position for which he wishes to make application. These applications must be filed with the Commission at Washington by the night of April 3.

GEO. F. FENNO, for the last 2 yr. insurance engineer with the Middle States Inspection Bureau, has resigned in order to join the staff of the Geo. H. Gibson Co., advertising engineers, Tribune Bldg., New York City. Mr. Fenno is a graduate of Sibley College, Cornell University, class of 1906, and for some time after leaving school was telephone engineer for the New York and New Jersey Telephone Co. His experience with the Middle States Inspection Bureau has given him wide familiarity with the engineering and manufacturing plants, a knowledge which will be valuable to him in his present work of pro-

moting the sale of engineering supplies and equipment by means of publicity.

A. EUGENE MICHEL, who as manager of a technical advertising organization has for the past few years been identified with the publicity of numerous large manufacturing concerns, has just opened new offices at 1572 Hudson Terminal Buildings, New York. Mr. Michel will in future confine his efforts as an advertising engineer to the promotion of steam specialties and apparatus, power transmission appliances and machine tools, and will limit his clientele to the number of firms to whose work he can give personal attention.

Mr. Michel is a graduate engineer, associate member of the A. S. M. E., and with 11 yr. advertising and engineering training, which includes practical experience in machine design, testing, etc., is well prepared to conduct the advertising of mechanical products. Among the accounts which Mr. Michel will handle are the following: Watson-Stillman Co., the Bird-Archer Co., the Diamond Mfg. Co., and James Beggs & Co.

R. G. VON KOKERITZ & Co., manufacturers of durable packings, have removed from the Cable Bldg. to 114 Liberty St., New York, where they have commodious offices and ample store room.

ON FEB. 15 A MEETING WAS HELD at the Chemists' Club, in New York City, of the New York section of the American Peat Society. The subjects taken up were how to use the peat swamps in New York and adjoining states, and included an article by Professor Chas. A. Davis in regard to peat as an aid to the conservation of national resources, and discussion by Professor Robert Fernald, of the United States Geological Survey, on peat for gas producers, and a discussion on the utilization of peat in making fertilizers. In Western New York there are 3,000 square miles of peat deposits now worthless and the object of the meeting was to show how these might be made valuable.

THE ILLINOIS MANUFACTURERS' ASSOCIATION has passed resolutions calling on all Senators and Representatives of Illinois in the National and State Legislatures to discourage all measures having a tendency to continue or aggravate the agitation against corporate interests, and to support all legislation which, without injury to their constituents, will tend to allay the hostility toward business conducted under corporate form, including manufacturing, commercial and transportation companies, while the new laws on the statute books are being tried out; and urging all municipal and civic bodies, corporations, transportation companies and individuals to refrain from any acts that will cause agitation or disturbance which will retard the return of prosperity and favorable business conditions to the end that in the resulting quiet, commercial and all other interests may have an opportunity to more quickly recover the golden days of prosperity heretofore enjoyed.

These resolutions coming from an association which has been active in protecting the rights of shippers and in asking for concessions where deserved is worthy of special attention, as indicating a reaction in the attitude of the public toward the railroads. It was natural that the arrogant attitude of some railroad officials should cause hard feeling on the part of those who "paid the freight" and that the watering of stocks and other juggling should create distrust among investors. A spirit of revenge produced some unwise legislation intended to throttle rather than to regulate railroads and other corporations. But the American spirit of fair play is coming to the front and the feeling that some actions have been too radical is followed by the wish to live and let live. There have been laws enough for awhile; the proper spirit now is all pull together for the general good and forget past misdemeanors unless it becomes evident that further transgressions are contemplated, a condition that is not likely after the severe criticism and punishment that have been administered.

ROBERT THURSTON KENT has resigned as engineering editor of the Iron Trade Review, Cleveland, Ohio, to become managing editor of Industrial Engineering, Pittsburg, Pa., a new paper devoted to mechanical engineering subjects. Mr. Kent has been with the Iron Trade Review since 1905, and prior to that time was associate editor of the Electrical Review, New York.

TWO NEW NATIONAL FORESTS have recently been established by proclamation, one in Marion County, Fla., the Ocala Forest, and one in Billings County, N. D., the Dakota Forest. Both are on land of practically no value for farming and now giving but a meager growth of timber. Much of the Ocala land has been devastated by fire, but the uninjured portion shows good possibilities. The Dakota reservation will serve as an experiment station to develop a satisfactory method of growing timber in the scantily timbered Dakota section. The Florida section forest has 201,480 acres, and the Dakota 14,080.

LUBRICATION OF GOVERNOR-PINS

In our last month's issue in reporting the efficiency of the lubrication of governor-pins on Westinghouse high-speed engines, through a misprint it was stated that 46 ounces of Keystone grease were used per week of 13 consecutive shifts on each of 5 Westinghouse engines at the plant of the Electric Storage Battery Co., Philadelphia. This statement should have been 4 to 6 ounces of this lubricant. While regretting the error in the original report of this performance of Keystone grease, we are glad in correcting same to call attention to the small consumption required in governor-pin lubrication. By the use of Keystone grease the safe and effective lubrication of governor-pins becomes merely a matter of filling up a small grease cup once a week when the engine is shut down; the nature of this lubricant, which is a pure, natural, petroleum product, being such that it takes care of itself after the cup is once filled. The success of Keystone grease on high-speed engines under existing conditions is an instance of the general reliability of this well known product.

CATALOGUE NOTES.

A DIRECTORY OF ENGINEERS and Power Plants is always a convenient, often a necessary book for those engaged in power plant merchandizing. While several other cities have been supplied with such directories, New York has not until now; but the newly issued Directory of Engineers and Power Plants of Greater New York was worth waiting for. It is complete as a directory of plants, giving the names of plants in alphabetical order, their location and equipment and the name and home address of the chief engineer, this list being divided geographically by boroughs. It has a separate alphabetical directory of engineers, giving their home addresses. These 2 make it especially valuable to those who wish to reach the engineers or the plants.

For the engineer it is of assistance because it has a complete telephone directory of the leading engineers' supply houses classified according to the goods that they handle, a directory of national and state en-

gineers' organizations, indexes to advertisers and to supply houses and 30 pages of useful information on engine operation, boiler tending, pumps, condensers, and the action of electrical machinery.

It contains altogether 320 pages and is published by the Engineering Directory Co., of 2447 Beekman St., New York City.

ANALYSIS OF FLUE GASES is worth careful attention, for it means the detection and checking of numerous sources of heat waste. The Welch CO_2 Analyzer is for this purpose and is described in a folder just received from H. H. Welch, 1575 Madison St., Chicago, Ill.

A MIGHTY CONVENIENT LITTLE CATALOG is the Pony No. 76 just sent out by Dean Bros. Steam Pump Works, of Indianapolis. This shows by cross sectional views the action of the different styles of pumps made by Dean Bros., and by means of dimension tables, halftone illustrations and descriptions gives an idea of a few of the many lines for which this concern has complete patterns in stock. This includes boiler feed pumps, fire pumps, tank and light service pumps, air compressors, heavy service and mine pumps, crank and flywheel type ammonia pumps, air pumps and jet condensers.

FROM THE A. S. CAMERON Steam Pump Works, of New York, comes an interesting and instructive map of the Panama Canal, showing the canal zone and the trade routes which will be affected by its completion.

HARBISON-WALKER REFRACTORIES CO., of Pittsburg, Pa., issues a handsome leather bound catalog on heavy paper with gold edges, showing all the styles of fire brick suitable for arches, furnaces, chimney linings, boiler settings and metal furnaces. It gives sectional views of settings of all prominent makes of boilers, showing where fire brick should be used, and tables showing the numbers of brick and quantity needed for arches of different kinds and sizes. It is handsome and handy.

A RECENT LIST OF PUBLICATIONS ISSUED by Allis-Chalmers Co. shows 187 bulletins and instruction books which that company has prepared, or has in course of preparation, exploiting the products of its various departments which include the manufacture of prime movers of every description, electrical apparatus for alternating and direct current, pumping machinery, mining machinery, crushing and cement making machinery, flour mill machinery, saw mill machinery, etc. Information descriptive of all of the above is indexed in a convenient manner and, as a reference, this is valuable.

Allis-Chalmers Co.'s publications are illustrated by cuts of the most modern appliances and methods, and in addition to the descriptive matter, which can be had on application, this index of publications contains the numbers and titles of several valuable instruction books.

RENSSELAER POLYTECHNIC INSTITUTE, of Troy, N. Y., has established courses in mechanical and electrical engineering and in a booklet issued in December of last year, which has just reached this office, the equipment provided for these courses is illustrated.

TESTS OF FRICTION CLUTCHES FOR POWER TRANSMISSION is the title of a pamphlet by R. G. Dukes, issued by the Hill Clutch Co., of Cleveland, Ohio. It shows the results of a series of comparative tests on different types of clutches, the Hill clutch being the one which gave the greatest horsepower transmission for a given number of pounds' pressure on the collar.

CHAPMAN VALVE MFG. CO., of Indian Orchard, Mass., in Bulletin No. 1 gives a complete description of its electrically operated valves and shows their application for steam stations, for hydraulic plants, for manufacturing plants, for municipal water supply and for fire protection systems. Bulletin No. 2 describes the Chapman sluice gate and gives the details of arrangement for both hand and motor operation. The bulletin includes dimension lists and drawings for different sizes.

FOR DRIVING GAS ENGINES, natural gas and furnace gas are not always available, but in such cases producer gas can nearly always be generated and can be made from almost anything that will burn, including such fuels as lignite, slack and bone coal, which cannot be used under boilers for making steam. Underlying the public lands of the United States are lignite beds of from 20 to 30 million acres, which, although valueless as steam fuel, are available for producer gas use. A bulletin recently issued by the Allis-Chalmers Co., on gas engines, shows the fields of power service in which gas engines are available and the economies afforded by using them.

MONARCH MACHINE WORKS, of Altoona, Pa., are sending out an interesting and inspiring illuminated motto suitable for hanging up in an engine room.

ATLAS ENGINES AND BOILERS is the title of a new catalog. As the name implies, it describes in detail the machinery built by the Atlas Engine Works, of Indianapolis, and, like the preceding catalogs from this company, it is a beauty. The machinery described in the catalog consists of the Atlas Corliss engines of different types, the Atlas enclosed high-speed engines, both 4 valve and single valve, Atlas twin engines and the Atlas gas or gasoline engines. In the boiler section are taken up the Atlas water-tube boilers, different styles of horizontal tubular boilers, smoke connections, breechings, Scotch marine boilers, locomotive boilers, portable and semiportable outfits, and boiler accessories. At the end of the catalog are 50 pages devoted to useful information covering the subject of heat values, coal costs, making of steam, horsepower of engines and boilers, sizes of chimneys, the proportions of riveted joints, the power of pulleys, belts and ropes, proportions of piping and boiler tubes, and the circumferences and areas of circles. Engineers will find this a valuable book.

THE THIRTY-THIRD EDITION OF THE CATALOG OF Keuffel & Esser Co., which has just been published, is the largest as yet issued by this firm, and will, no doubt, be of great interest to every engineer.

The general appearance of the catalog has been much improved and it is handsomely bound. Interspersed throughout the book are fine illustrations showing for the first time the interiors of the general office and factory buildings at Hoboken, N. J., which the company now occupies, as well as glimpses of the stores in New York, Chicago, St. Louis, San Francisco and Montreal.

An important change in the general arrangement of the catalog has been made by creating a special section for drafting office-furniture, which is now forming an important department among the goods manufactured.

It would lead too far to enumerate the many additions made to the various lines of drafting instruments, surveying instruments, etc., but they will be readily

noticed by those familiar with the previous editions.

The catalog contains some 540 pages and will be sent to engineers, free of charge, on application.

FROM THE GREEN ENGINEERING CO. comes a new catalog G describing in detail the Green chain grate stokers. It is not only a handsomely gotten up catalog but is interesting as well because of the clear and complete way in which the different styles of chain grate are shown. The frame, grate links, driving mechanism, arch construction and setting are all clearly illustrated and fully explained. At the end of the book are tables of the heating values of coals from the principal Ohio, Illinois and Pennsylvania districts.

ONE OF THE MOST NOTEWORTHY DEVELOPMENTS in the history of mechanical progress during the past few years has been the constantly increasing use of compressed air for a great variety of purposes. Pneumatic tools and other appliances for the utilization of this product have been gradually introduced from one field of activity after another. A simple type of air compressor and one adapted for a great variety of purposes is described in Allis-Chalmers Co.'s bulletin 1513. This is a portable outfit equipped with a direct or alternating current motor and the compressor with its various accessories can be brought directly to the work instead of having its product transmitted from a distance through pipes and flexible tubing.

DUBOIS GAS ENGINES and producer gas plants are made in the factory of the DuBois Iron Works at Dubois, Pa., and are attractively described in the novel and handsome catalog just issued by the company. It tells about single cylinder, tandem and twin engines for use on natural, illuminating or producer gas, giving general appearance, details and method of connection and operation for the types for general and for electric power service. The sectional diagrams of engine mechanism are particularly instructive.

THE FEBRUARY ISSUE of the Publicity Magazine, published by the Under-Feed Stoker Co. of America, describes a number of interesting installations of Jones Under-Feed Stokers, novel installations being those on shipboard, one in the Providence Retreat at Buffalo, N. Y., and one in the Pluma (S. D.) Power & Light Co. plant.

THE GIRL FROM STEPHENSON'S has called this month and is the prettiest yet. She has an elegant hat and a pair of eyes you ought to see. Send an invitation to the Stephenson Mfg. Co., of Albany, N. Y., and she will call on you.

THE EASE WITH WHICH THE TUNGSTEN LAMP is adapted to street lighting is shown in Bulletin 4647, just issued by the General Electric Co. There is no lamp of small or moderately large units of light that is as economical as the tungsten series lamp, and it is, therefore, ideal for suburban and residential street lighting.

The bulletin contains curves showing candlepower distribution of this lamp under different conditions, illustrations of constant current transformers and series lamp sockets used in connection with the lamp, and several diagrams showing the advantages to be derived from the use of the tungsten lamp for series street lighting.

CAMERON CONDENSING APPARATUS is a description of the extended line of such apparatus now made by the A. S. Cameron Steam Pump Works, of New York. The pamphlet includes matter on barometric and centrifugal jet condensers, surface condensers, circulating, dry-vacuum and hot well pumps, and exhaust relief valves. This is issued as a supplement to the No. 35 illustrated catalog of steam pumps, which covers the complete line designed for all purposes and in all sizes.

FEAR NOT TO SOW is the caption of a neat, combined calendar and blotter issued by the Geo. H. Gibson Co., Advertising Engineers, Tribune Bldg., New York City. They advise manufacturers of engineering supplies and equipment to prepare the way for large sales during the resumption of business by means of intelligently directed, educational publicity. They contend that advertising tends to reduce rather than increase the percentage expense of selling; that it leads to the education of the buyer as to the latest and most improved processes and methods; that it encourages intelligent and discriminating buying; that it leads to the perfection of the product in order that the latter may have the strongest claims to the buyer's consideration. The growing indications of an approaching resumption of business in engineering lines, renders these matters of timely interest to manufacturers of engineering products.

A PUBLICATION which should be of considerable assistance and interest, especially to central station managers, has just been issued by the General Electric Co. In preparing this publication on the design of switchboards an effort has been made to discuss only representative cases, pointing out both the desirable and undesirable features. The bulletin, which is numbered 4638, goes into details, giving the arrangements, dimensions and connections of various styles of boards.

METHODS OF COOLING WATER for steam condensing and other plants are fully described in Bulletin 104, on Water Cooling Towers just issued by the Wheeler Condenser & Engineering Co., of Carteret, N. J. After explaining the physics of water cooling the different types of cooling towers are discussed, more especially the Wheeler-Barnard tower, the essential feature of which is the use of a galvanized woven, wire mat as the filling medium over which the water trickles. This tower is built on the forced draft, natural draft and open styles, and the numerous full-page illustrations adequately show its construction and manner of installation. There are also various tables on humidity, air and vapor, mixtures, etc., which should be of value to engineers.

TRADE NOTES

SPON & CHAMBERLAIN are issuing a handy little device for the computation of wire sizes in lighting circuits called the Herrick Planigraph which computes for a given distance current and voltage, the size of wire, or for a given distance current and size of wire the volts drop, or for any three of the variables the fourth quantity without the use of figures. It is a convenient chart and a time saver for anyone who has to figure electric circuits.

HAVE YOU HAD ANY EXPERIENCE in repairing cracks or holes in castings or bad joints in pipe with the Smooth-On cement or tape? We are asking this question because it is to your interest to answer it. The Smooth-On Mfg. Co. wants photographs and sketches of such repairs and descriptions of how you

did it. They are willing to pay you for your trouble in getting this material for them and for the expense of photographs or drawings. This is a chance for you to help out your fellow engineers and also to get pay for your expense and time in doing so. You can send photographs and descriptions direct to Practical Engineer, Chicago, Ill., or to the Smooth-On Mfg. Co., 572 Communipaw Ave., Jersey City, N. J. Don't think because your job was a small one that it is not of interest. We want records and illustrations of any repair which you may have made with these materials.

SOME OF THE PRINCIPAL RECENT SALES of the Ohio Blower Co. are these: Up-current oil separator to Acme Woolen Mills Co., Cleveland, Ohio; 14-in. cast-iron exhaust head to Victoria Lumber & Mfg. Co., Chemainus, B. C.; cast-iron exhaust head for Schmidt Lithograph Co., San Francisco Cal.; vertical separator to United Brick Co., Greensburg, Pa.; 3 separators for the Ohio Soldiers' and Sailors' Orphans' Home, Xenia, Ohio; 12-in. horizontal oil separator for Colonial Salt Co., Akron, Ohio; steam separator for the Logan Coal Co., Lloydell, Pa.; steam separator for Sargent & Co., New Haven, Conn.; cast-iron exhaust head for Vermejo Park, New Mexico; 2 cast-iron exhaust heads for Youngstown Sheet & Tube Co., Youngstown, Ohio; 10-in oil separator for Shantz Thomas Brewing Co., of Dayton, Ohio; steam separator for Carolina Bagging Co., Henderson, N. C.; exhaust head for Greenwood Cotton Mills, Greenwood, S. C.; 10-in. vertical steam separator for Hampton Co., of Easthampton, Mass.

THE BUCKEYE BOILER SKIMMER CO., of Toledo, O., received the following letter from Gilmore Bros., of the same city, in reference to the operation of the Buckeye boiler skimmer: We have used your skimmer on our 2 dredges the past 3 years and find that they do all that you claim for them. We have worked alongside of other dredges, equipped with the same style of boiler, and whereas they have had to clean their boiler every 2 weeks, we run 8 weeks before cleaning and then find no mud or scale. We open up our boilers every 8 weeks, more to inspect them than in the expectation of finding any mud or scale. We figure we save double the price of the skimmer each season in fuel and time.

THE H. W. JOHNS-MANVILLE CO., of New York, has placed upon the market new types of closet seats and tanks which are molded in one piece from indurated fibre. This material is familiar to most of us in connection with fibre pails, wash tubs, water cooler tanks, etc. This material is nonporous and cannot absorb water; therefore no lining is required in tanks made of it, which does away with the danger of corrosion. The exact grain of mahogany and oak is transferred to these seats and takes so perfectly that few would be able to distinguish them from wood. The manufacturers are sending a sample of this material and descriptive booklet to interested parties.

BURNING OF CRUDE OIL is one of the problems receiving careful attention in many parts of the country. A new device which has many valuable features has recently been patented by R. C. Nelson, of Healdsburg, Cal., to whom the following letter was sent by C. E. Hearing, an engineer in the same city:

"After operating many different kinds of burners, and none of them giving me the satisfaction that I desired, I concluded to try the Nelson system. Will state that with considerable experience that I have had, it is by far the best system that I have ever used. For simplicity of operation, and above all, the saving in oil, I believe it to be the best system on the market."

THE TAYLOR GRAVITY UNDER-FEED STOKER is a novelty in a method of feeding fuel to the boiler. It is manufactured by the American Ship Windlass Co., of Providence, R. I., and is described fully as to arrangement, details of construction, method of operation and results which it will give, in a handsome catalog of 40 pages, which can be had by writing to the company.

AMONG THE RECENT SALES made by the York Manufacturing Co. are the following: Ferd. Munch Brewery, Brooklyn, N. Y., one 100-ton compression side; South Bethlehem Brewing Co., South Bethlehem, Pa., one 40-ton compression side; Ocala Manufacturing Co., Ocala, Fla., one 60-ton compression side, 20-ton freezing and distilling system; Cudahy Packing Co., Wichita, Kansas, one 250-ton cross compound compression side; C. C. Woodin, Roslyn, L. I., one 10-ton ice making plant; B. Wilson & Co., Victoria, B. C., one 30-ton refrigerating machine and 15-ton freezing system; Hazelwood Cream Co., Portland, Ore., one 60-ton right hand compression side; Western Creameries Co., Bernicia, Cal., one 20-ton refrigerating compression side; Crystal Ice & Cold Storage Co., Uniontown, Pa., one 20-ton ice making plant; Henneberger Ice Co., Princeton, Ind., one 40-ton refrigerating machine; Las Animas Electric Co., Las Animas, Colo., one 30-ton refrigerating compression side, 10-ton freezing and distilling system; Goodman American Ice Cream Co., Chicago, Ill., one 30 and one 60-ton compression side, 20-ton freezing system; A. A. Crabbs, Blairsville, Intersection, Pa., one 4-ton refrigerating Plant; Consumers' Hygienic Ice Co., Union Hill, N. J., one 100-ton ice making plant; Cornie Stave Co., Junction City, Ark., one 10-ton ice making plant; Frank Lowe, East Liverpool, Ohio, one 10-ton refrigerating plant; Kokomo Sanitary Milk & Ice Cream Co., Kokomo, Ind., one 30-ton refrigerating plant; Schwarzschild & Sulzberger Co., Baltimore, Md., branch, one 10-ton refrigerating compression side; Gottfried Brewing Co., Chicago, Ill., one 175-ton cross compound refrigerating machine and high pressure side; Glen D. Finney, Eureka, Kansas, one 10-ton ice making plant; Dawson Bros., Corry, Pa., one 8-ton refrigerating plant; A. H. Klehamer, Rochester, N. Y., one 4-ton refrigerating plant; Jos. Meisenzahl, Rochester, N. Y., one 4-ton refrigerating plant; Klages Coal & Ice Co., Akron, Ohio, one 60-ton ice making plant; Crystal Ice Co., Piedmont, W. Va., one 20-ton ice making plant; Francis Perot's Sons' Malting Co., Buffalo, N. Y., one 60-ton refrigerating plant; La Grange Ice & Fuel Co., La Grange, Fla., one 25-ton freezing and distilling system; Moerlbach Brewery, Rochester, N. Y., one 60-ton compression side.

DUBOIS IRON WORKS, MANUFACTURERS of DuBois gas engines and steam and power pumps, have been awarded the contract for the complete equipment and installation of the pumping station for the Clarion water works, Clarion, Pa. The machinery purchased consisting of 1 150 hp. DuBois tandem natural gas engine geared to a 1,000,000 gal. pump. Also 1 50 hp. unit for driving an air compressor, 1 centrifugal pump, together with all necessary fittings, etc. The plant is installed as an auxiliary to the present steam pumping equipment, which will eventually be replaced by a duplicate of the new gas engine driven unit. The engines and pumps will work against a head of 685

ft., pumping through 4,000 ft. of 10-in. main to the standpipe. A complete new power station is being erected and the plant when finished will be one of the most efficient and modern of the kind in the country.

The DuBois Iron Works has also been awarded contract for a 160 hp. twin tandem gas engine, direct connected to 100 kw. generator for the lighting plant of the 74th Regiment State Armory Building at Buffalo, N. Y.

THE BUCKEYE BOILER SKIMMER CO., TOLEDO, OHIO, recently received the following letter in reference to its skimmer from the Central Dredging Co., of Bancroft, Ia.: We have used your skimmer on our dredge here in connection with a 60 hp. boiler, for 12 months, and part of the time under the most trying circumstances. We worked for 3 months on up stream work through peat sloughs. The water was thick with the vegetable matter and as bad for steam purposes as any water I have used in over 30 yr. experience on dredge and steam shovel work. We would have been obliged to clean the boiler at least twice each week and then probably would have cut the valves badly from the boiler foaming. By giving the skimmer the proper attention we run the boiler 3 weeks and were not troubled any with priming or foaming. Ordinarily we run from 6 to 8 weeks, but in this case the water was very thick with matter. There is no question about the skimmer being a great fuel saver.

THE EUREKA FIRE HOSE MANUFACTURING CO., 13 Barclay St., New York., has been at work for a number of years in perfecting what has recently been placed on the market as Eureka Solid Woven Cotton Belting. This belting is intended for both transmission and conveying, and is manufactured on special machinery owned by the company, and the invention of the president, R. L. Stowe.

Eureka Belting is woven under great tension in one solid body, and, therefore, has no plies to separate. A natural tendency of the belt in work is to form itself into a coil, which in service adheres to the pulley and makes a powerful drive, aided by the fact that the texture of the belt allows the escape of air from between the pulley and the belt.

Eureka belting is made treated and untreated. Treated belt will stand moisture and climatic changes, and both styles are so solidly put together that what stretch is necessarily left in the belting is minimized, avoiding the necessity of tighteners and annoying delays in taking up. Concerns which have tried this belting have unhesitatingly stated that under trying and at times unusual conditions, it has shown itself to be durable and reliable.

WANTED

"Positions Wanted" advertisements not exceeding 50 words for subscribers to Practical Engineer will be inserted twice free of charge. "Help Wanted" and special advertisements 25 cents a line.

POSITION

As electrician of manufacturing or power company, by young man, single, strictly sober, graduate of A. S. C. in electrical engineering. Two years' station experience. Left charge of 3,000 H. P. central station to attend college. Now ready for engagement. A1 reference. Moderate salary to start. Write, Verde Harbaugh, Ashland, Ohio. 4-2

POSITION

Engineer wants position. Thoroughly experienced with Corliss and slide valve engines. Now employed. Can give references. Address P. O. Box 218, Londonville, Ohio. 3-2

POSITION

Electrician, 12 years' experience. Can take charge of mill work. Considered an expert on mine equipment, mining machines, motors, also electric traveling cranes and full mill equipment. Can give best of references. Address F. C. Beck, Bridgeport, Ohio. 4-2

POSITION

To take full charge of small power or lighting plant, or as assistant in large one. Married man, aged 31. Fifteen years' experience wiring line work and care of motors and generators. Handled men for last 10 years. Best references from present employers. Address Box 99, care of Practical Engineer. 4-2

POSITION

By young man as engineer's helper, or fireman in a power plant, good worker; no bad habits. Some experience in traction engineering and has nearly completed I. C. S. course. Age 24. Will come on trial if not too far. Address Box 214, Spicer, Minn. 4-2

POSITION

Engineer now employed by Produce Cold Storage Co., wishes to make change. Experienced with steam and refrigerating machinery and pumps. Strictly sober and steady. Can furnish references. Address R. J. Carrier, 5 Montezuma street, Houghton, Mich. 3-2

POSITION

Gas engineer is open for position. Ten years' experience erecting and operating Westinghouse and Allis-Chalmers gas and steam engines. Past three years on gas engines exclusively. First class references furnished. Age 35. Married. Address Box 98, Practical Engineer. 3-2

POSITION

I wish to correspond with any company desiring the services of an up-to-date master mechanic or chief engineer. Thoroughly familiar with all kinds of repairs and reconstruction work in manufacturing plants. Address M. D. Morley, 112 Chadwick avenue, Newark, N. J. 3-2

POSITION

General superintendent and works manager will be at liberty February 1st. Ten years with high-class concerns in Middle West; experienced in foundry, machine, sheet metal, forge and woodworking lines, with up-to-date ideas of shop organization and practice on economical production. Address "Superintendent," 1105 N. Alabama Street, Indianapolis, Ind.

WANTED IMMEDIATELY.

A high grade salesman with experience in selling machinery and equipment in the power plant field. Must have a record showing ability to develop and close sales with big industrial establishments, consulting engineers and architects. Preference will be given to an ex-Allis-Chalmers or Westinghouse man, but consideration will be given all applicants. An excellent opportunity for the right man. Address Box 94, Practical Engineer.

FOR SALE

Twenty-five steam pumps of various sizes; one 5 ton dormant type cupola charging scale; one Root blower, size No. 5; one Connersville blower, 45 cubic feet capacity per revolution, direct connected to horizontal type Erie City engine; one Rand Imperial type duplex air compressor, capacity 245 cubic feet per minute; one 14½ in. x 20 in. Lansing automatic engine. Chattanooga Machinery Exchange, 112 Carter Street, Chattanooga, Tenn. 4-1

FOR SALE

60 steel storage tanks, 6,000 gallons' capacity. Good as new. Double riveted, extra well built. Suitable for storage of oils, waters or liquids of any kind. 100 steam pumps. Get our prices on engines, boilers and electrical machinery. All sizes and kinds. Chicago House Wrecking Co., 35th and Iron Sts., Chicago. 4 tf

ENGINEERS AND MECHANICS

To make big money selling Incomparable "ZIZ" Hand Soap. A 10-cent can will instantly remove more dirt and stains from the hands than four cakes of any soap made, and it will not injure the most delicate skin. Small sample free. Byram Mfg. Co., Box 3133, Boston, Mass. 4 tf

PATENTS

Watson E. Colman, Patent Attorney, Washington, D. C. Advice and books free. Highest references. Best services. 4 tf

PATENTS

C. L. Parker, late Examiner, U. S. Patent office, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Building, Washington, D. C. 4 tf